Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

1010 EMPIRE BUILDING | SEPTEMBER, 1942 | PITTSBURGH, PA.

TECHNOLOGY DEPT.

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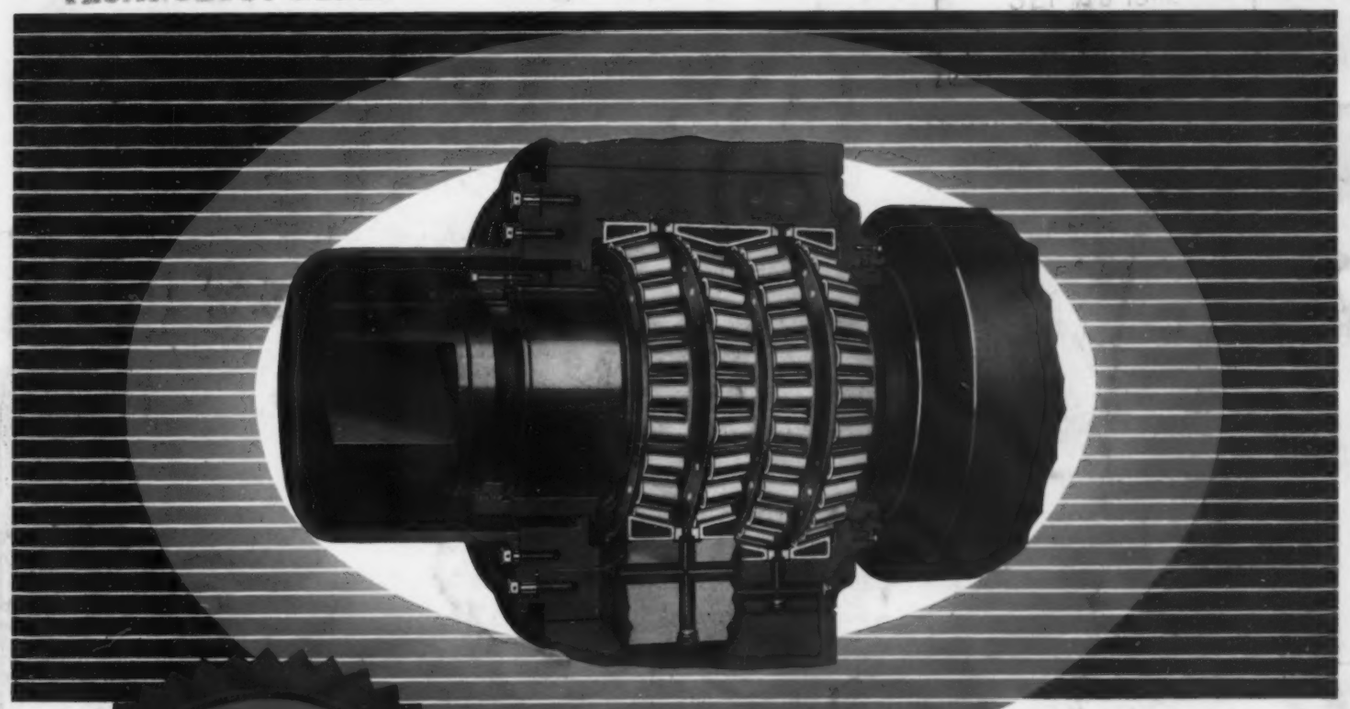


Keep' em rolling for Victory—reduce costs to meet competitive conditions afterwards. Put Timken Bearings on all roll necks. Redesign now.

Roll neck bearings are being put to the test now as never before. As far as Timken Roll Neck Bearings are concerned however, it is only a confirmation of the efficiency, endurance and economy they have displayed during the last fifteen years in rolling millions of tons of steel at the lowest bearing cost per ton ever attained.

With Timken Bearings on all back-up and work-rolls you are assured of continuous, dependable operation; no involuntary shutdowns for roll replacement; simplicity of lubrication; ease of roll changing—no delicate parts to handle.

Existing mills can be brought up to victory production standards with Timken Roll Neck Bearings. Consult the mill builder, or get in touch with our roll neck bearing specialists.

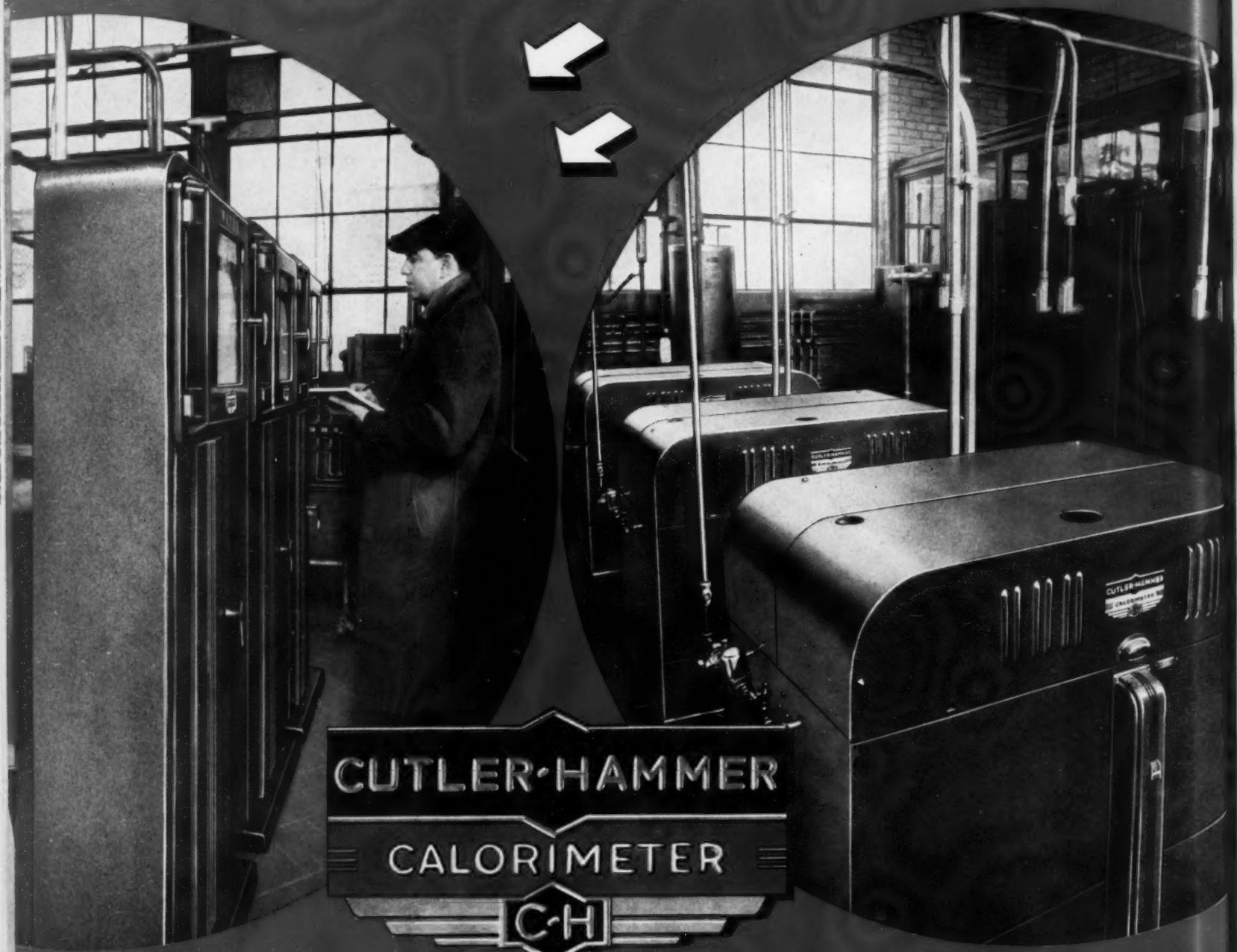
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

For Closer Control of STEEL MILL GAS OPERATIONS



TODAY, unceasing production demands more rigorous process control than ever before. Leading Steel companies find the high accuracy and faster response of the *new* Cutler-Hammer Calorimeter a vital element in accurate and efficient control of gas operations.

Whether your gas is coke oven gas, blast furnace gas, natural gas or refinery gas, the fast-acting Cutler-Hammer Calorimeter tells you *immediately* what the Btu value is—of any one of them or any mixture. Its accurate Btu measurements help immeasurably in producing perfectly stabilized interchangeable gases for the highest possible efficiency of your pre-heating furnaces, open hearths, or normalizing furnaces.

It measures the Btu's directly by burning a small sample of gas. It continuously records these values on a 30 day chart. The new suppressed zero scale enables you to make *micrometer* readings at a glance. An eight-hour record is visible at all times.

For more control, for more stabilized gas mixtures, for economy and high efficiency of gas operations, look to the new C-H Calorimeter. Write for complete technical information. CUTLER-HAMMER, Inc., *Pioneer Electrical Manufacturers,* 1366 St. Paul Avenue, Milwaukee, Wisconsin.

Now's the time when a *Save to Win* policy is just what the doctor ordered. An ounce of prevention is better than a pound of cure, when you're caring for vital tools and equipment.

For instance, your long-lived, dependable Exide Batteries will last even longer if given reasonable, normal care. Follow these simple rules and *Save to Win.* That's good medicine for you, and bad medicine for the Axis.

MAKING BATTERIES LAST HELPS STOP THE AXIS!

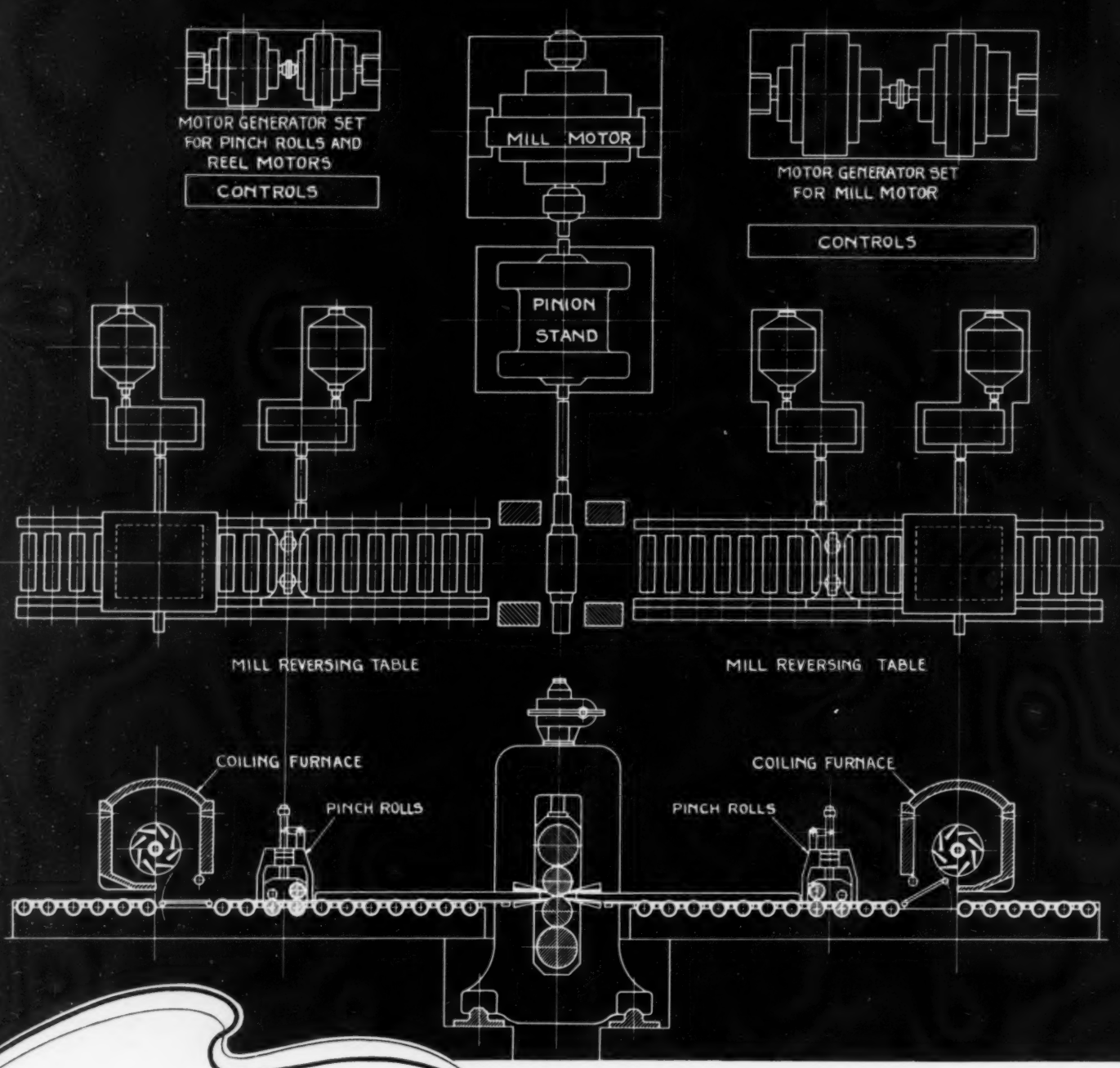
1. Keep adding approved water at regular intervals. Most local water is safe. Ask us if yours is safe.
2. Keep the top of the battery and battery container clean and dry at all times. This will assure maximum protection of the inner parts.
3. Keep the battery fully charged—but avoid excessive over-charge. A storage battery will last longer when charged at its proper voltage.
4. Record water additions, voltage, and gravity readings. Don't trust your memory. Write down a complete record of your battery's life history. Compare readings.

If you wish more detailed information, or have a special battery problem, don't hesitate to write to Exide. We want you to get the long-life built into every Exide Battery. Ask for booklet Form 1982.

THE ELECTRIC STORAGE BATTERY CO., Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

Exide
IRONCLAD
BATTERIES

AN UNUSUAL ACHIEVEMENT THAT SIMPLIFIES HO



COLDMETAL
SINGLE STAND
Reversing
HOT STRIP and PLATE MILL

LOWER INITIAL INVESTMENT—LOWER OPERATING COST FOR PRODUCTION OF COILED STRIP, HOT ROLLED SHEETS CUT TO LENGTH, HEAVY AND LIGHT GAUGE PLATE AND FLOOR PLATES

● For producers requiring increased hot strip production or those considering new investments in hot strip mills, we invite a thorough investigation of ColdMetal's achievement. Literally, ColdMetal has reduced a mountain to a mole hill — actually lessened equipment necessary to produce metallurgically correct high quality hot strip. Naturally, this means large savings in original investment and continued savings accrue because of the lower operating cost.

THE COLDMETAL HOT STRIP MILL IS EXTREMELY FLEXIBLE TO PRODUCTION REQUIREMENTS

HOT ROLLED STRIP PRODUCTION

1 DIRECT ROLLING FROM INGOT OR SLAB INTO STRIP — NO REHEATING

2 ELIMINATES NECESSITY FOR COSTLY BLOOMING MILL . . . . . .

COMPLETE INSTALLATION REQUIRES LESS INVESTMENT THAN COST OF A BLOOMING MILL

● The ColdMetal Hot Strip Mill provides advantageous equipment for production at peak operating periods or for more variable requirements in lessened operations. Rolls can be changed in about fifteen minutes for conversion to needs thus allowing extreme flexibility of production. Interesting to many operators is the particular adaptability to rolling of high carbon and alloy steels. The temperature of the strip can be controlled during the rolling cycle which assures a high metallurgical standard. Another advantage gained with temperature control is a more uniform gauge — thus longer coils of maximum weight.

● Direct rolling from ingots into strip as achieved with ColdMetal's reversing hot strip mill completely eliminates the necessity of a blooming mill. This fact alone means less investment — for equipment and building space. Still greater emphasis is brought to the tremendous advantage ColdMetal reversing hot strip mills offer when it is noted that a complete installation costs less than an investment in a blooming mill.

ColdMetal invites your inquiry and is prepared to give you complete facts after learning your requirements. Your immediate investigation now may solve an important production problem of a later date. Ask for a ColdMetal representative to call, or write for information today.

COLDMETAL

THE COLD METAL PROCESS CO.

Affiliate Company
THE COLD METAL PRODUCTS CO.

YOUNGSTOWN, OHIO

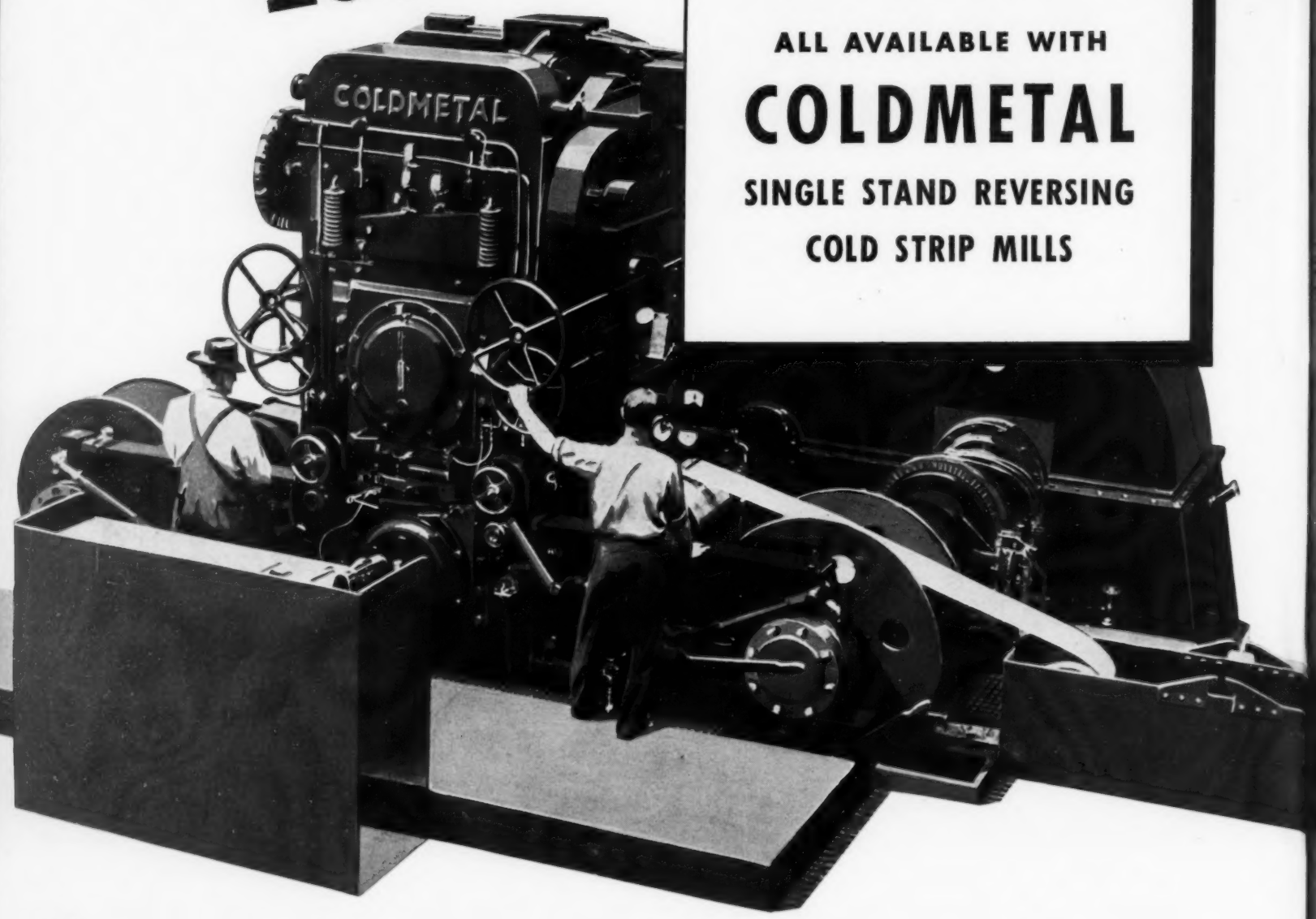
SPEED PRECISION ECONOMY

VITAL ADVANTAGES!

ALL AVAILABLE WITH

COLDMETAL

SINGLE STAND REVERSING
COLD STRIP MILLS



COLDMETAL
COLD STRIP MILL
FACTS
1 Faster Rolling Speed
2 Holds Closer Tolerances
3 Fewer Anneals in Reduction of Alloy, High Carbon and Stainless
4 Easier Control of Uniformity

Cold rolled strip producers are today realizing more than ever the full advantages of ColdMetal mills. Having made possible the doubling of rolling speed over recent years it has enabled them to keep pace with increased tonnage demand without sacrificing the qualities of accuracy and precision. It all points to the production betterment that a ColdMetal mill offers under any operating condition. When you consider the precision control that provides uniformity and close limits, the fewer anneals required for the reduction of alloy, high carbon and stainless plus the production speed, many economies are obtained that lower costs. More important however, is the reliance on ColdMetal mills to produce the highest quality precision strip which has materially improved customer relationship for operators everywhere.

Standard equipment on ColdMetal mills includes the gauging device. Additional savings are obtained in the nominal cost of single motor type electrical equipment as compared to three motor drive. Get all the facts now on ColdMetal mills — there is a size to meet your requirement — complete information upon your inquiry.

COLDMETAL

THE COLD METAL PROCESS CO.

Affiliate Company
THE COLD METAL PRODUCTS CO.

YOUNGSTOWN, OHIO

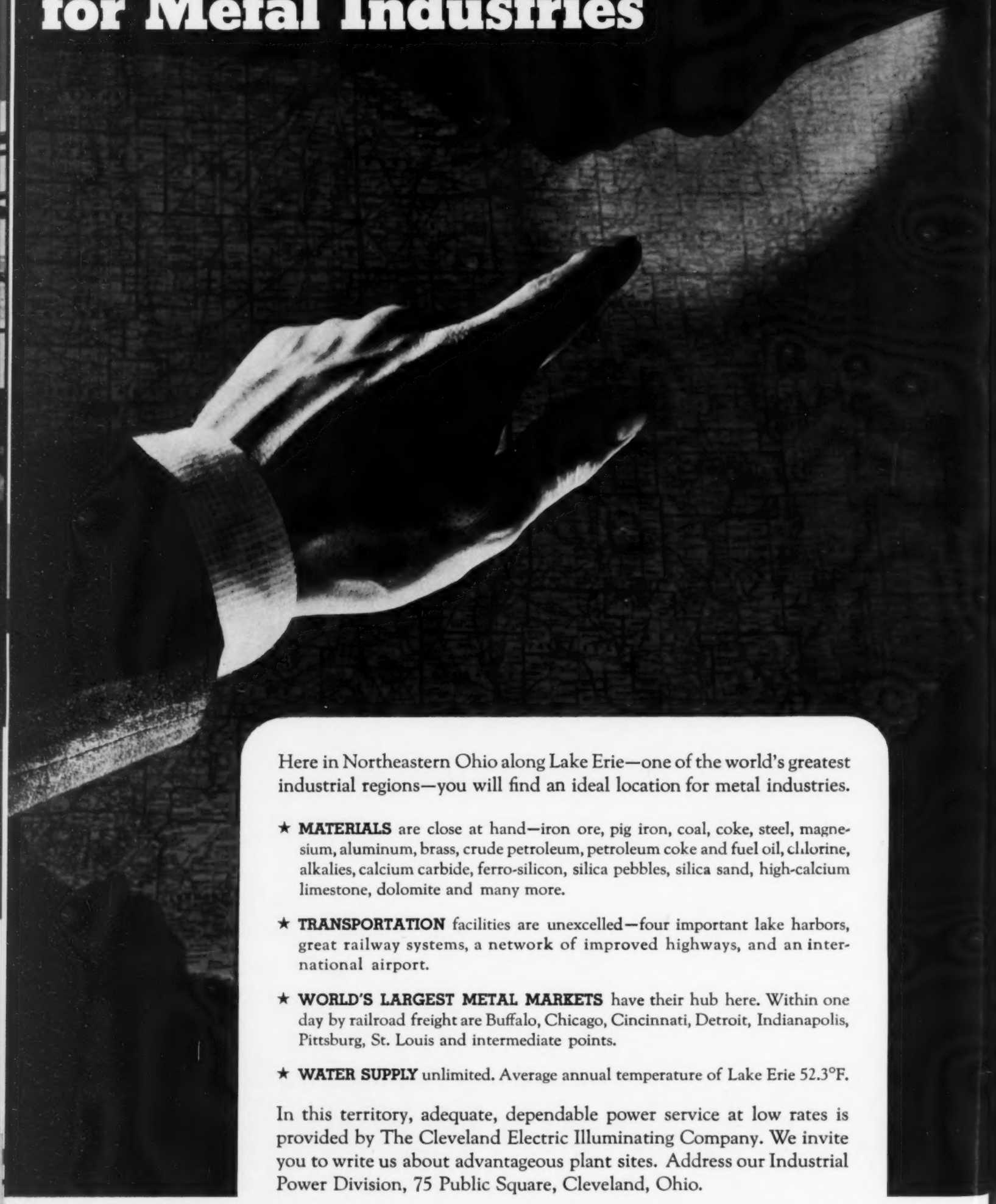
"The Resistor you can Install and Forget"

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI, OHIO

An IDEAL Location for Metal Industries



Here in Northeastern Ohio along Lake Erie—one of the world's greatest industrial regions—you will find an ideal location for metal industries.

★ **MATERIALS** are close at hand—iron ore, pig iron, coal, coke, steel, magnesium, aluminum, brass, crude petroleum, petroleum coke and fuel oil, chlorine, alkalies, calcium carbide, ferro-silicon, silica pebbles, silica sand, high-calcium limestone, dolomite and many more.

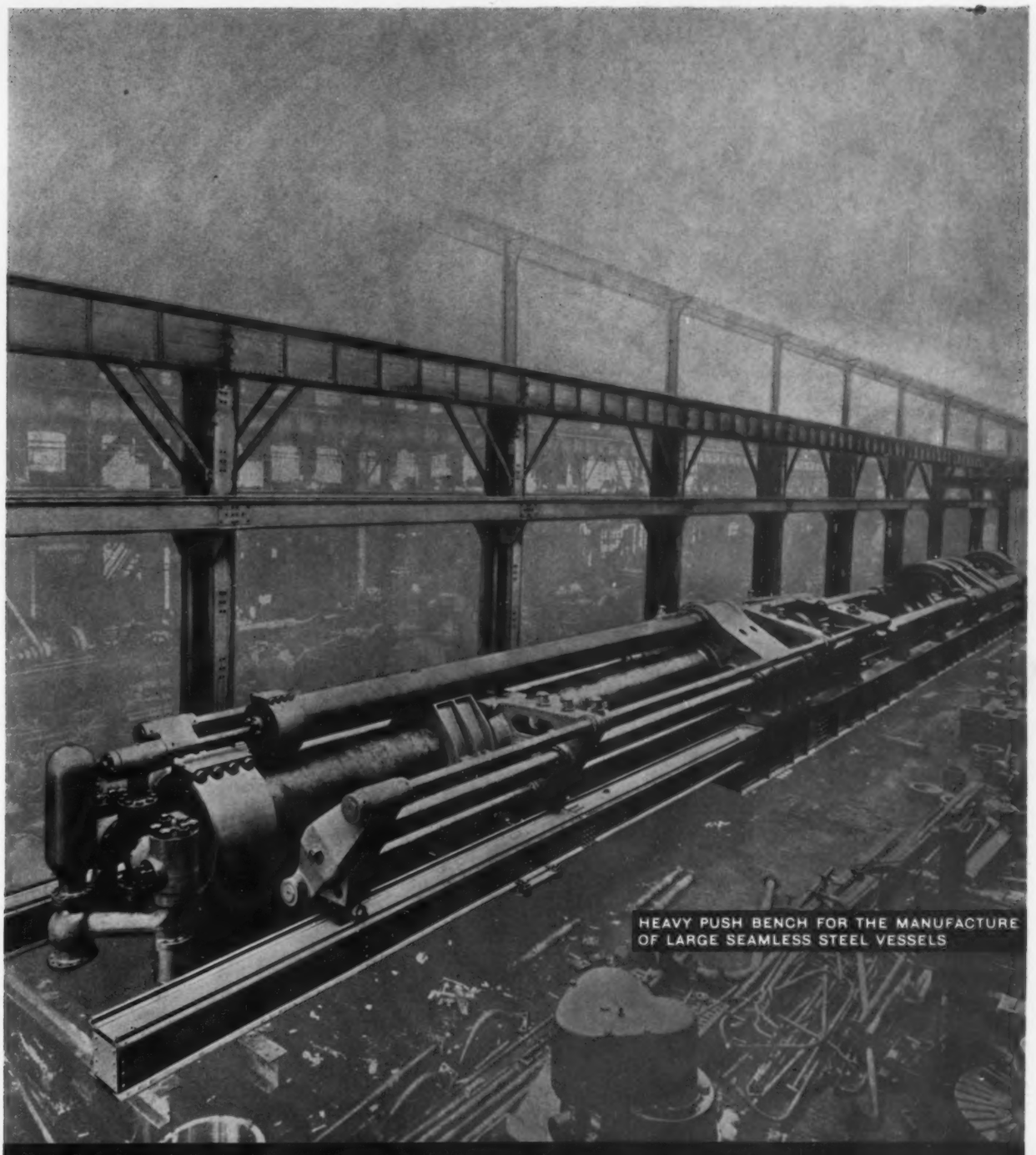
★ **TRANSPORTATION** facilities are unexcelled—four important lake harbors, great railway systems, a network of improved highways, and an international airport.

★ **WORLD'S LARGEST METAL MARKETS** have their hub here. Within one day by railroad freight are Buffalo, Chicago, Cincinnati, Detroit, Indianapolis, Pittsburg, St. Louis and intermediate points.

★ **WATER SUPPLY** unlimited. Average annual temperature of Lake Erie 52.3°F.

In this territory, adequate, dependable power service at low rates is provided by The Cleveland Electric Illuminating Company. We invite you to write us about advantageous plant sites. Address our Industrial Power Division, 75 Public Square, Cleveland, Ohio.

THE CLEVELAND ELECTRIC ILLUMINATING COMPANY



HEAVY PUSH BENCH FOR THE MANUFACTURE OF LARGE SEAMLESS STEEL VESSELS

HYDROPRESS · INC.

ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS
PUMPS · ACCUMULATORS

570 LEXINGTON AVENUE • NEW YORK • N. Y.

The STEEL MEN

While many others slept

IN the 1930's, while many industries were inclined to look for deeper depressions, these steel men *expanded*. There was no talk of war then; steel men had faith in America's future and foresaw the need for more and better steel.

They took long strides to gain both *increased* production and *unfailing* production. They added new capacity—and every one of them selected safety metal-enclosed switchgear to protect and distribute their vital electric power. Steel men started the sweeping trend to G-E metal-clad.

We know how priceless this additional steel production is today. We can see, too, how it grew out of faith and foresight, in the '30's. And we can be assured, from the performance of our steel mills today, that steel men are now being guided by the same remarkable foresight while industry marches into the fabulous '40's.

There's real foresight behind this Roll of Preparedness

1934 A hot-strip mill in Youngstown

1934 A cold-strip mill in Youngstown

1935 A blooming mill in Pittsburgh

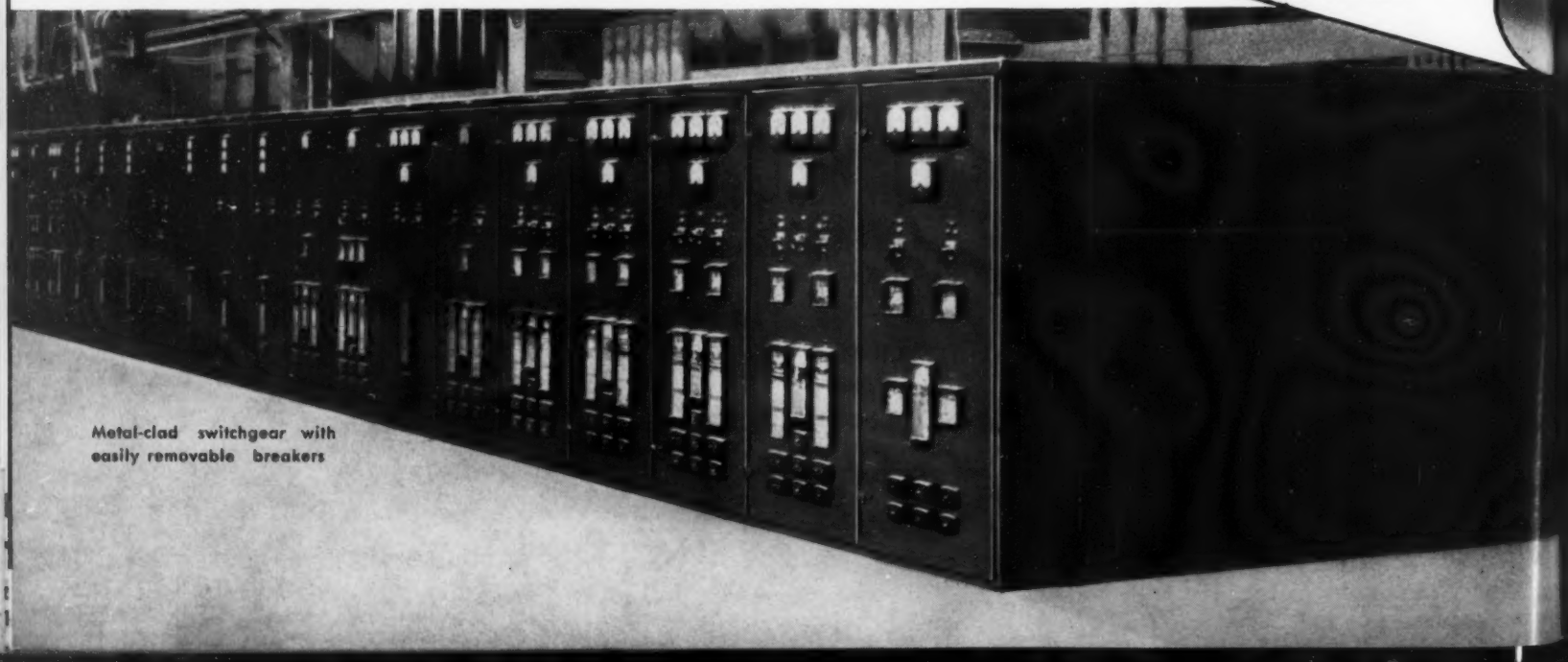
1935 A hot-strip mill near Buffalo

1935 A cold-strip mill in upper Ohio Valley

1935 A hot-strip mill near Detroit

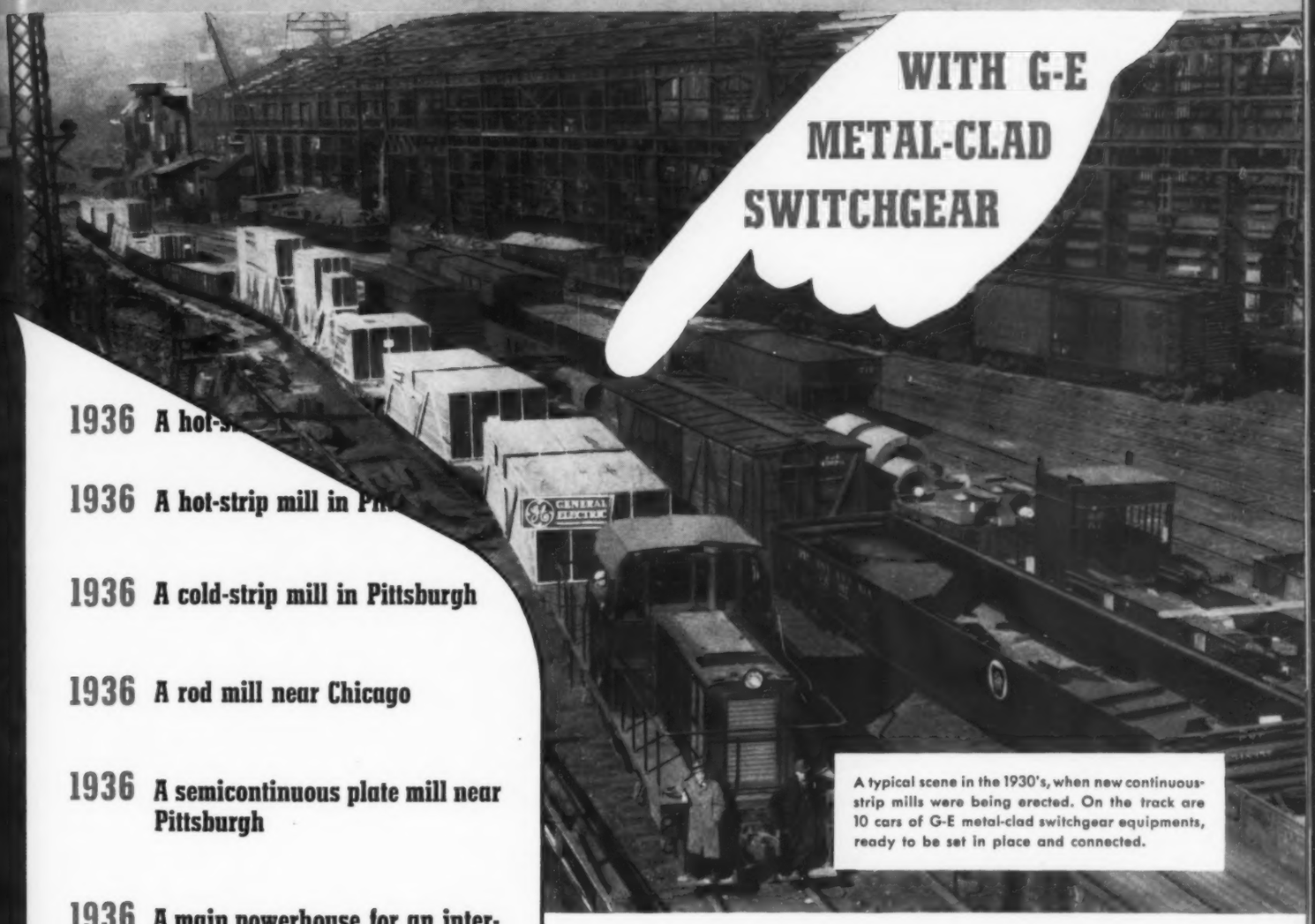
1935 A cold-strip mill near Baltimore

...ill in Cleveland



Metal-clad switchgear with easily removable breakers

BUILT FOR TODAY



A typical scene in the 1930's, when new continuous-strip mills were being erected. On the track are 10 cars of G-E metal-clad switchgear equipments, ready to be set in place and connected.

1936 A hot-s...

1936 A hot-strip mill in Pit...

1936 A cold-strip mill in Pittsburgh

1936 A rod mill near Chicago

1936 A semicontinuous plate mill near Pittsburgh

1936 A main powerhouse for an interconnected steel-mill system in the Monongahela Valley

1937 A hot-strip mill in Cleveland

1937 A cold-strip mill in Cleveland

1937 A rod mill in Baltimore

1937 A hot-strip mill near Chicago

1937 A new hot-strip mill near Pittsburgh

. . . AND THEY ARE BUILDING NOW *for TODAY and TOMORROW*

TONS of steel *returned* to these mills in the '30's—for use in new construction, in electric drives, in G-E metal-clad switchgear. Today, every bit of that steel is working. Every pound is helping to turn out huge, additional quantities of steel for the battlefront. And as steel production swells even more to provide swarms of fighting machines, steel men continue to demand G-E safety metal-clad switchgear. *They know that extra protection of personnel and extra assurance of uninterrupted power will be invaluable tomorrow, just as it is today.*

The Navy "E", for Excellence, has been awarded to 92,780 General Electric employees in six plants manufacturing naval equipment

GENERAL ELECTRIC

Who told Hitler we wouldn't fight?

Someone — whoever it was — blundered badly in the Greater Reich.

Hitler's international Auslander Organization — spies, to us — informed him that America would collapse before a shot was fired.

Internal dissensions would destroy us, and our industries would fall like ripe plums into the Nazi orbit.

Instead — 45,000 tanks, 60,000 planes, 20,000 anti-aircraft guns, 8,000,000 tons of shipping, *and more!*

Many U. S. Industries Beat War Production Schedules . . . YALE Pump Division Keeps a Year Ahead

Like many a U. S. industry, we at Yale & Towne's Pump Division have long realized that output considered good enough last December 6, would not be good enough today.

As a result, America's war industries and our Armed Forces are now receiving Yale Rotary Piston Pumps in *1943* quantities. And yet, Yale quality has been preserved throughout.

Yale pumps, which today cut fluid-handling costs, save fluid-handling time for victory, will be increasingly available to solve *your* fluid-transfer problems in the peacetime future.

TRADE YALE MARK
Pump Division

THE YALE & TOWNE MANUFACTURING COMPANY
STAMFORD, CONNECTICUT, U. S. A., PUMP DIVISION

Trabon

Steel Mill Lubricating Systems

—measure up fully to industry's most exacting requirements. They assure the positive delivery of just the desired amount of lubricant to each connected bearing. Trabon is the recognized standard for blast furnace tops—slabbing and rolling mills, overhead cranes and all other steel mill machinery... Descriptive literature, suggestions and recommendations furnished gladly—No obligation. Trabon Engineering Corporation, Cleveland, O.

Watch 'em Operate..

Let One-Way-Fired Soaking Pits in Action Demonstrate Their Distinctive Features...

Will they do the work... better, faster, at lower cost? Surface Combustion answers this question by inviting you to come and watch SC pits in actual operation.

Scores of one-way-fired pits are in use in leading steel plants. Surface Combustion engineers will arrange to take you, at your convenience, to see two or three or more jobs—not on display, not on test, but *hard at work in the production of steel for war.*

Your own observation will convince you that these distinctive SC advantages are not theoretical, not imaginary... but real.

SURFACE COMBUSTION . . . TOLEDO, OHIO

ADVANTAGES ★

Speed for War Production Calls for Greater Capacity, Greater Fuel Saving, Less Maintenance . . . and

SC PITS GIVE THEM ALL!

Features That Outmode Older Type Pits:

★ **Simpler Construction**—Burners and outlet flues located in one end wall. All other walls and the hearth are solid masonry backed by heavy steel binding. This is the simplest, sturdiest, longest-lived type of construction available for heating ingots.

★ **Increased Capacity**—In a given floor space, one-way fired pits can usually be laid out to provide double the ingot capacity of the typical regenerative pit layout.

★ **More Efficient Firing**—Fuel is admitted through properly designed burners, located in one end of the pit. There is continuous, uninterrupted travel of flame across the tops of ingots. Flame then doubles back in a horseshoe and the burned gases are exhausted through separate ports below the burners. Heating is by both radiation and convection.

★ **Better Heat Distribution**—Scientific burner design, regulating degree of premix and velocity of gas stream, affords complete control of atmospheric conditions and temperature distribution. Double travel of flame gives even temperature throughout the pit. Scale formation and oxidation losses greatly reduced.

★ **Fuel Economy**—Burners are scientifically designed. Air is preheated. Flame travels entire length of pit and then back. Combustion and furnace pressure control are automatic. Pits can be amply insulated against heat losses. The result—lower fuel costs.

★ **Greater Ingot Yield**—One-way pits can be fired up to maximum b.t.u. liberation in the combustion space available without injury to either equipment or steel. This permits maximum speed in heating steel—combined with increased capacity means much greater ingot yield.

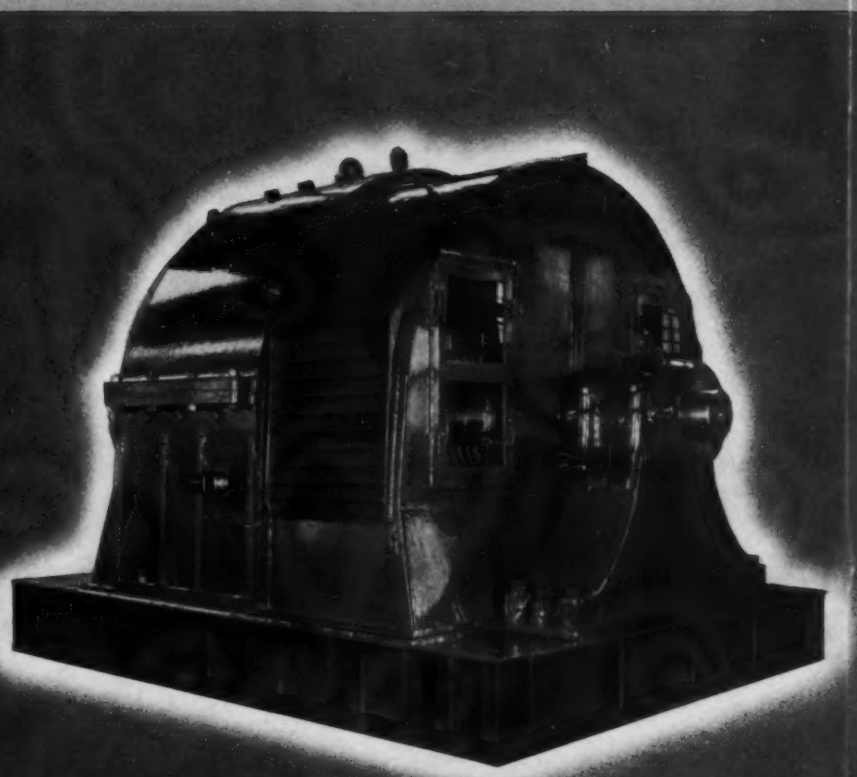
★ **Lower Maintenance**—Inherent design features insure low maintenance: (1) Protected location of burner ports; (2) refractory arch is protected as direction of firing is parallel with arch; (3) recuperator is located so that amount of cinder or slag carry-over is negligible; (4) no reversing valves to wear out; (5) less materials used in construction.

SURFACE SC COMBUSTION

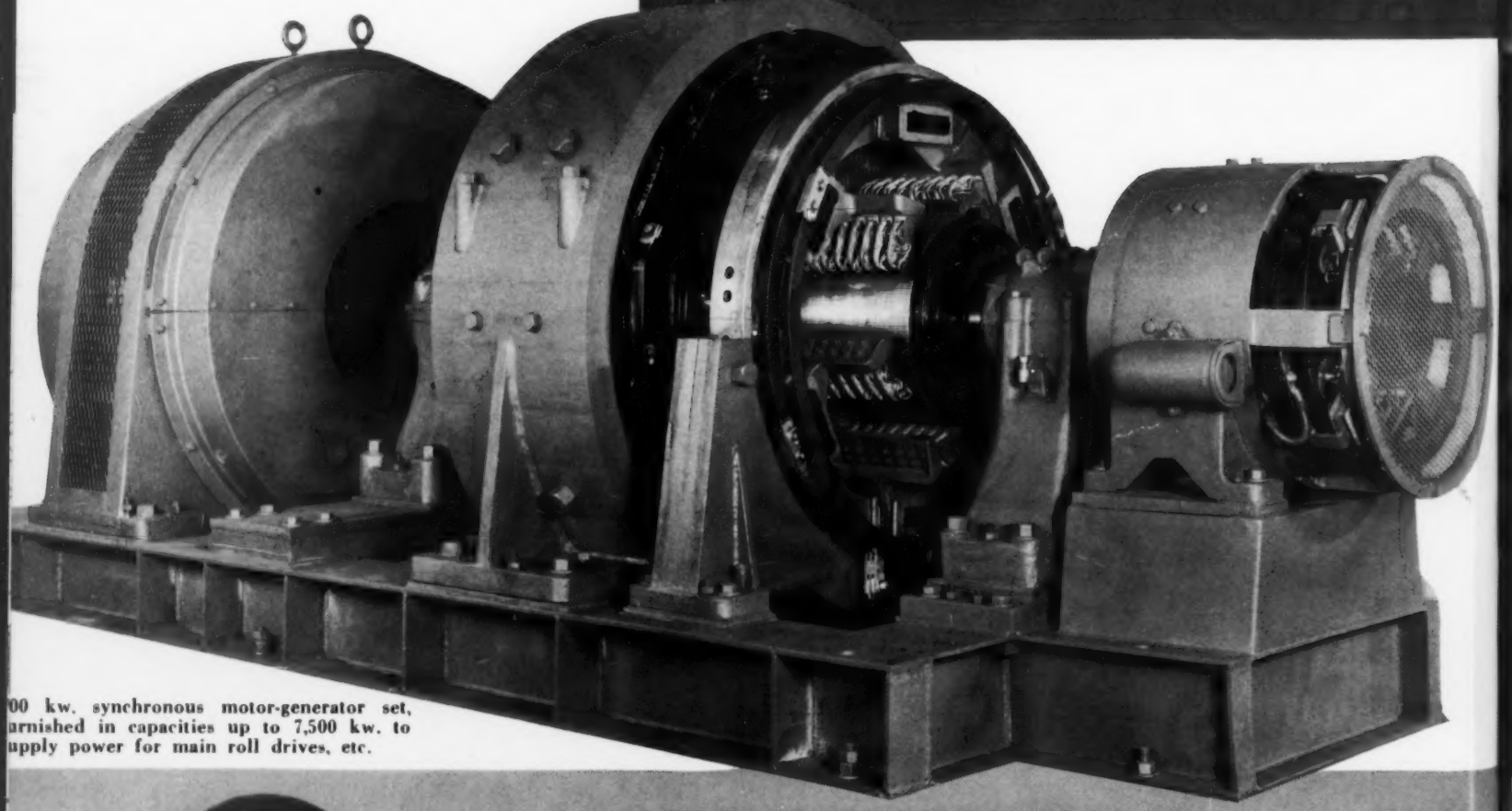
MANUFACTURERS OF INDUSTRIAL FURNACES • JANITROL GAS-FIRED SPACE HEATING EQUIPMENT • AND KATHABAR SYSTEMS FOR DRY BLAST

CROCKER - WHEELER MOTORS

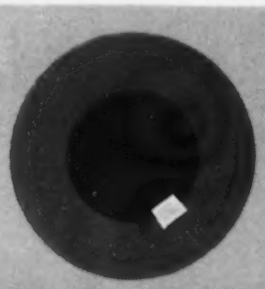
. . . meeting the 24-hour a day requirements of the vital steel industry for the Victory program



1000 hp., 250/750 rpm., 600 volt, direct-current motor to operate Steckel Mill. Crocker-Wheeler builds d-c motors for main roll drives, and for operating slab squeezers, trimming sheers, levellers, etc.



00 kw. synchronous motor-generator set, urnished in capacities up to 7,500 kw. to upply power for main roll drives, etc.



CROCKER-WHEELER PRODUCTS

Polyphase Induction Motors, ¼ to 10,000 horsepower. Synchronous Motors, 15 to 10,000 horsepower. Polyspeed Motors, 1 to 7½ horsepower. Direct Current Motors, ¼ to 5,000 horsepower. Alternating Current Generators, up to 7,500 kilowatts. Motor-Generator Sets, up to 7,500 kilowatts. Flexible Couplings, for shaft diameters up to 5 ins.

AND MOTOR-GENERATOR SETS

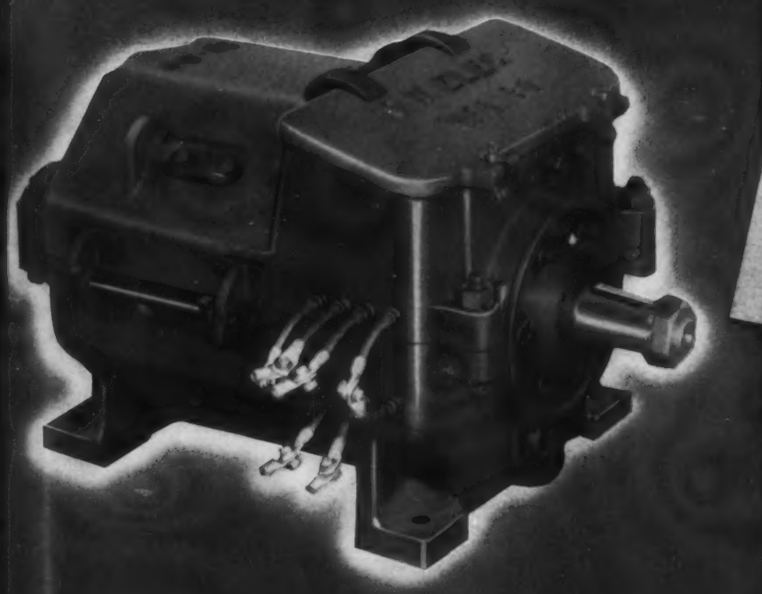
"Engineers have depended on Crocker-Wheeler products for steel mill applications since 1904—but never has this dependability been more needed than at the present time."

Standing in good stead, in the national emergency, is the pioneering by Crocker-Wheeler some four decades ago. Without the specially designed units now operating in key steel plants, the vast production would not now be so far ahead of schedule. Steel mill tonnage is dependent upon continuous operation; power failures, service interruptions and equipment breakdowns cannot be permitted.

Crocker-Wheeler motors and motor-generators are specifically designed and constructed to perform efficiently and dependably, even under severe operating conditions. All deteriorating and destructive elements have been considered — moisture, dust, fumes, corrosion, heat, acids, etc. That is why Crocker-Wheeler products are doing their job today . . . and will, for the tomorrows to come.

Crocker-Wheeler offers two informative volumes for prolonging the service life of direct-current generators and induction motors. The coupon below will bring your copies promptly, without obligation of course. Merely fill it out and mail today.

Crocker-Wheeler builds a complete line of auxiliary mill motors (conforming to A.I.&S.E. standards), 5 to 150 hp., plain and countershaft types.



KNOW YOUR GENERATORS

This manual for prolonging the life of generators, covers installation, operation, repairs and replacements — together with full instructions for proper maintenance — is a handy guide for engineers and plant superintendents.

ELIMINATE MOTOR REPLACEMENTS

The correct installation, care and operation of induction motors will assist in the conservation program. An instructive, helpful data book expressly compiled to keep your motors running.

CROCKER-WHEELER

CROCKER-WHEELER ELECTRIC MANUFACTURING COMPANY · AMPERE, N. J.

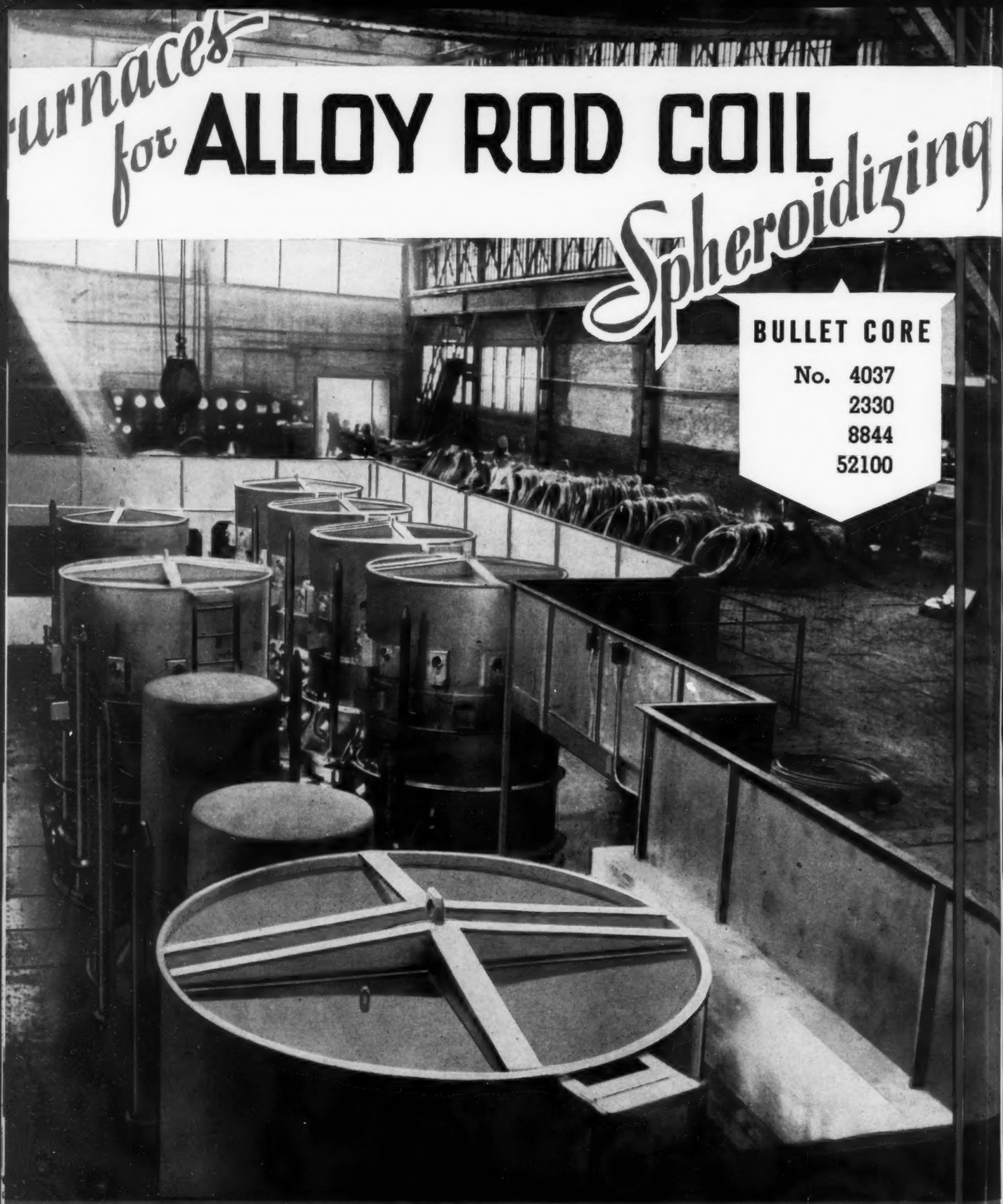
DISTRICT SALES OFFICES:
BOSTON, MASS. · BUFFALO, N. Y. · CHICAGO, ILL. · CINCINNATI, OHIO · CLEVELAND, OHIO · DETROIT, MICH. · NEWARK, N. J. · NEW YORK, N. Y. · PHILADELPHIA, PA. · PITTSBURGH, PA. · SAN FRANCISCO, CAL.

IN CANADA: COMMONWEALTH ELECTRIC CORPORATION, LIMITED, WELLAND, ONTARIO

Gentlemen:
You may send me the Instruction Book for
Generators.....
for Induction Motors.....

NAME.....
FIRM.....
ADDRESS.....
CITY..... STATE.....

Furnaces for ALLOY ROD COIL Spheroidizing



BULLET CORE

No. 4037
2330
8844
52100

Lee Wilson ENGINEERING Co.

20005 West Lake Road CLEVELAND, OHIO

Telephone AC-4670

The Wilson Annealing Unit is covered by Patents Nos. 1932402, 2004477, 2074334, 2081613, and other patents pending.

SPEED UP *BILLET CHIPPING* AS MUCH AS 90%

CLEAR FOR ACTION!

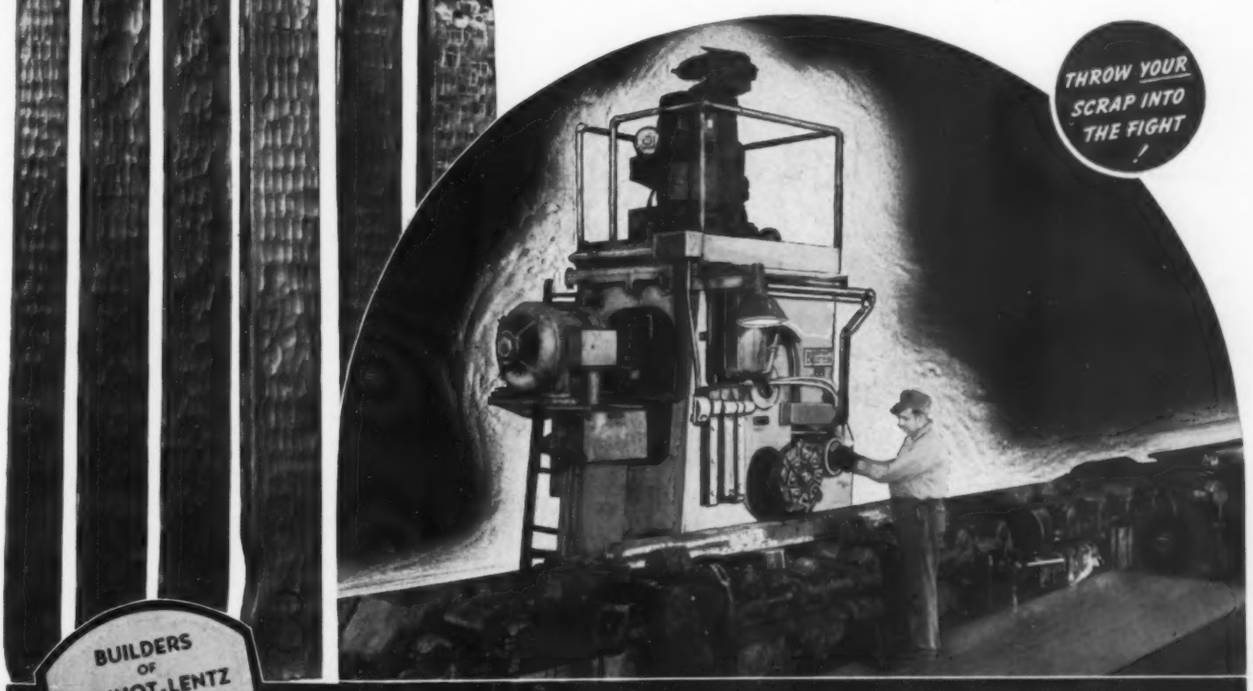
Speed has always been important to economical production — but today it is even more important to the all-out Victory drive. Have you checked on the possibilities of speeding up billet-chipping? Do you know that the

BILLETEER

and *one* operator will clean as many billets as a crew of 10 to 20 skilled workmen with air chipping tools? Furthermore, the Billeteer easily and economically salvages billets that heretofore were unprofitable to clean by hand.

These are cost-cutting features, too, that mean supremacy in peace as well as in war.

Very high priority rating has been given this equipment. We have been unable to keep pace with the demand for the Billeteer, so talk it over with one of our sales engineers NOW, and place an order for quickest possible future delivery.



BUILDERS OF BONNOT-LENTZ BILLETEERS ALSO CRUSHING PULVERIZING AND MIXING EQUIPMENT

THE Bonnot COMPANY
STEEL EQUIPMENT DIVISION
CANTON, OHIO

NORTH AMERICAN
COMBUSTION EQUIPMENT

Will save fuel for your country and your company!

GAS BURNERS

OIL BURNERS

GAS
OIL
STEAM

AIR
WATER
COMP. AIR

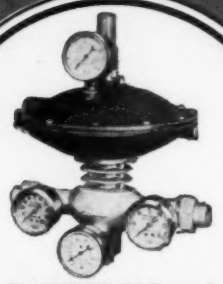
ADJUSTABLE PORT VALVES

DESIGNED
TO WORK TOGETHER
AS A UNIT GIVING YOU
ONE
SOURCE OF SUPPLY
ONE
RESPONSIBILITY

TURBO BLOWERS

OIL AIR

SENSITROL OIL and BUTTERFLY AIR VALVES

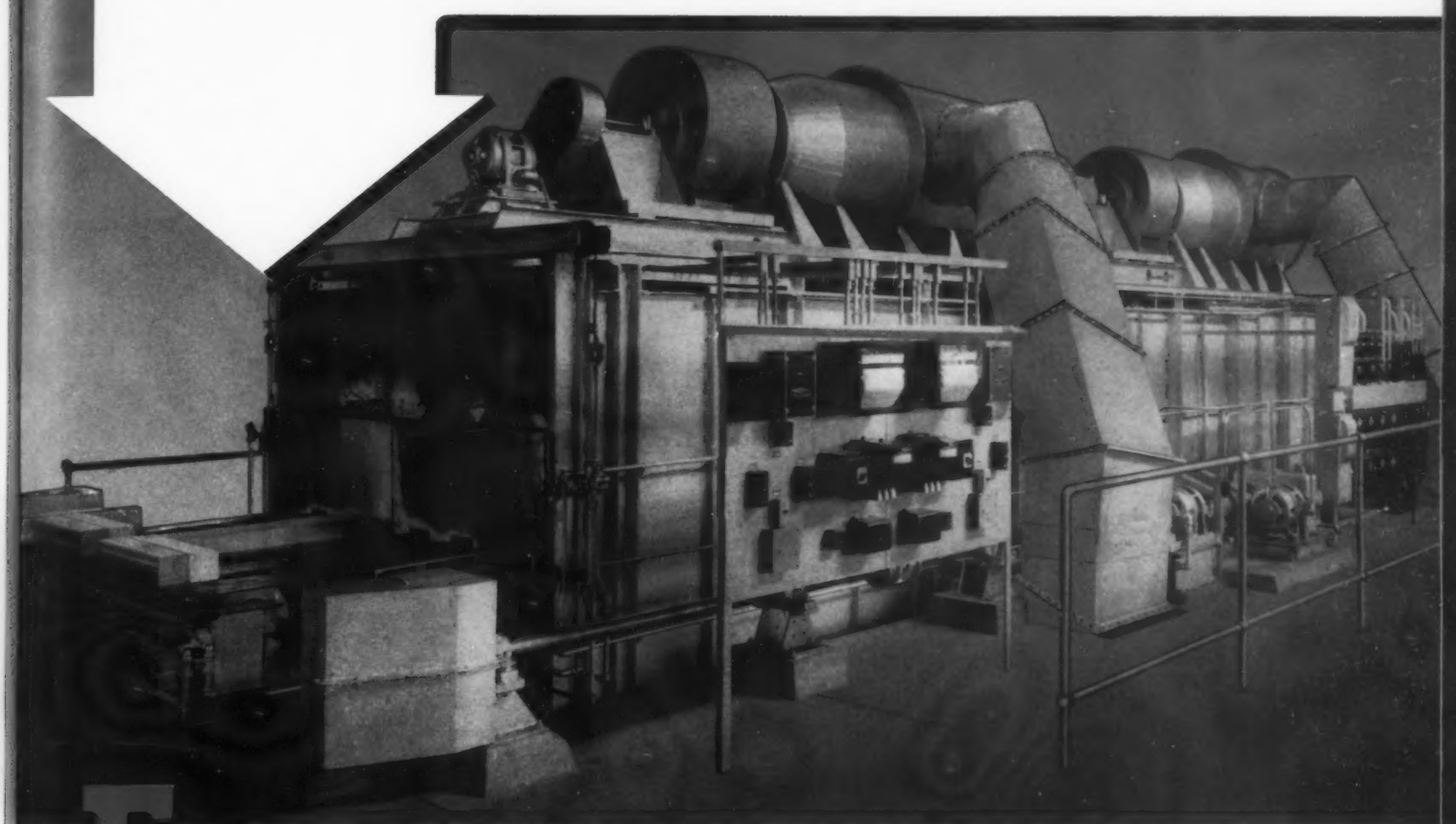


RATIOTROLS and REGULATORS

Why not consult a North American representative?

THE NORTH AMERICAN MANUFACTURING COMPANY
MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL
BRANCH OFFICES *with* FIELD ENGINEERS *in* PRINCIPAL CITIES
CLEVELAND, OHIO

How to Heat Aluminum Billets Uniformly On a High Production Basis . . . . .



FURNACE CAPACITIES TO MEET YOUR NEEDS

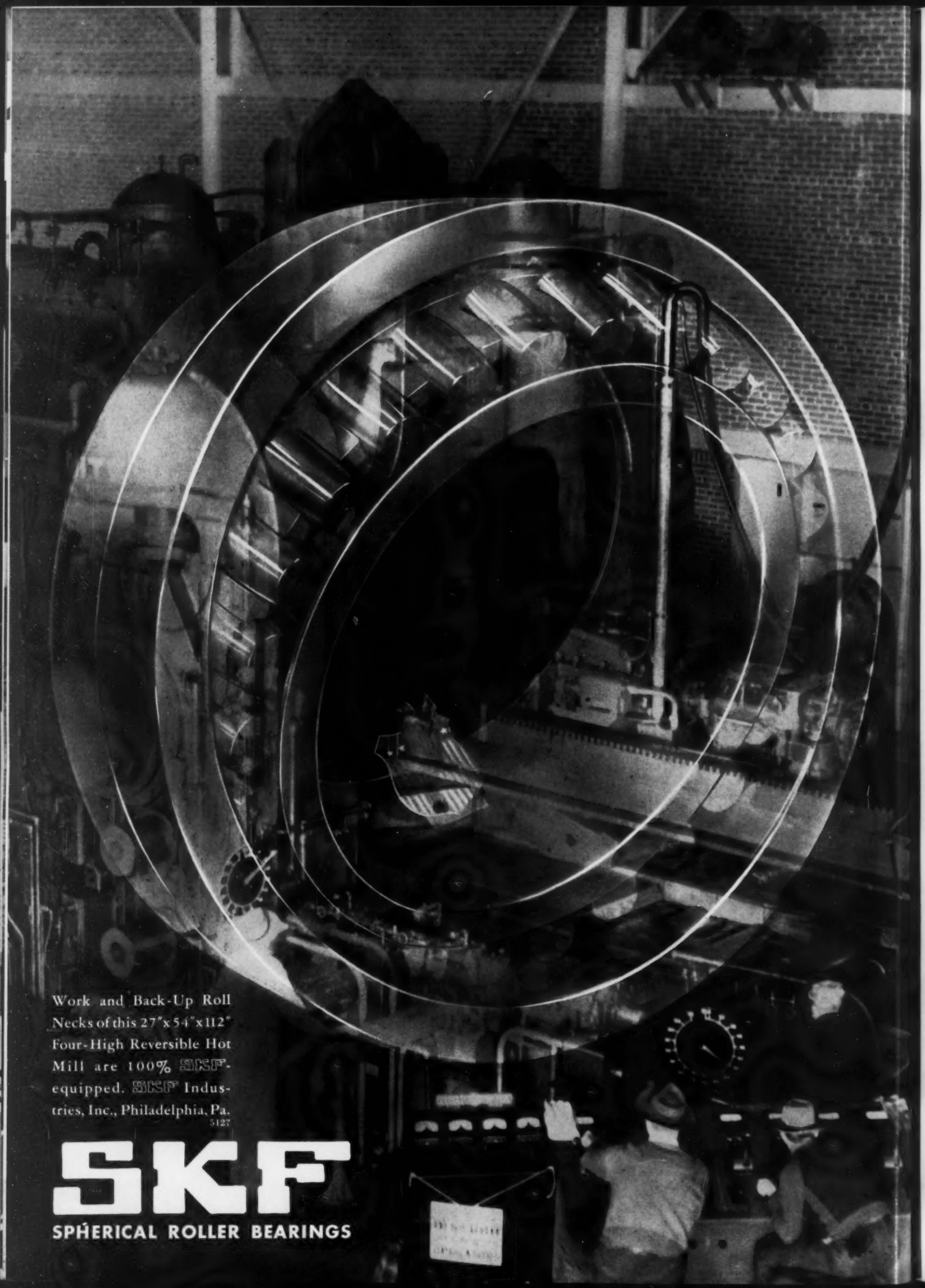
Salem equipment becomes more than just heating mechanisms. The illustrated convection type furnace, for example, is synchronized into plant production which precedes the heating operations as well as the manufacturing procedures which follow.

It heats aluminum billets prior to rolling or extrusion operations. Rows of billets, stacked at least three high, move in and out of the chamber on several strands of chains. By merely pushing a button after removing one top billet, the direction of travel reverses so that the remaining billets may be held inside the furnace until needed.

External convection heating units at the top of the furnace are oil fired and products of combustion circulate completely around the billets. Predetermined temperature is controlled by thermocouples. Hence, uniform heating proceeds dependably at a fast rate. The furnace above heats over 6000 pounds of various size billets per hour, and other larger or smaller units are available to meet your requirements. Salem has had broad experience in heating all types of metals. Write today.

SALEM ENGINEERING COMPANY

SALEM ENGINEERING CO. • SALEM, OHIO



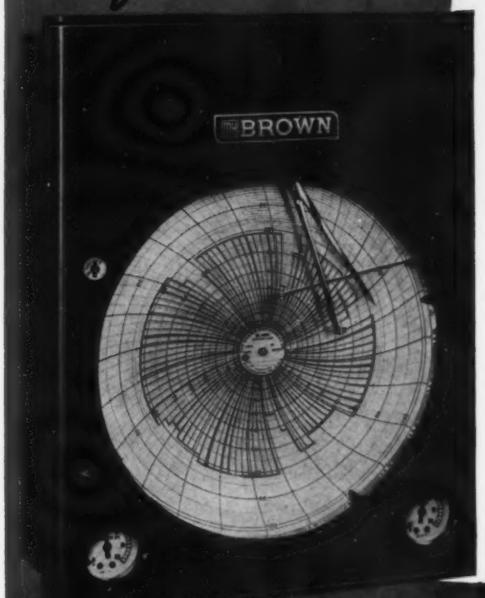
Work and Back-Up Roll Necks of this 27"x54"x112" Four-High Reversible Hot Mill are 100% SKF-equipped. SKF Industries, Inc., Philadelphia, Pa.

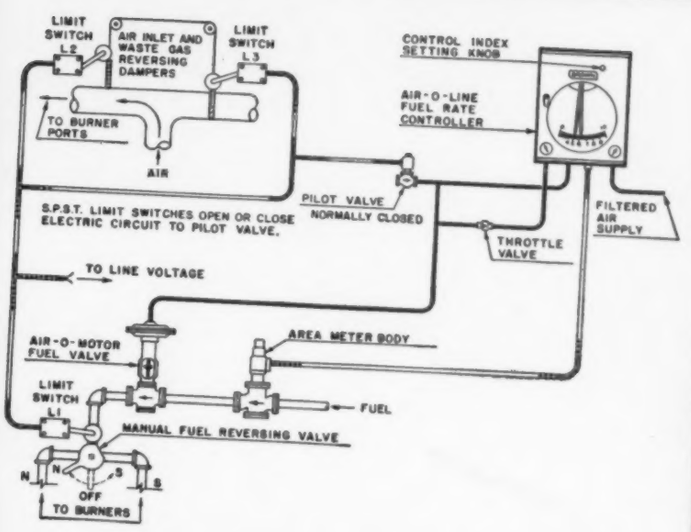
5127

SKF

SPHERICAL ROLLER BEARINGS

Ideal Fuel-Flow Control System for REGENERATIVE FURNACES





IF "all out" production orders have you pushing for greater tonnage — efficient furnace control is essential.

You can rely on the above Brown Penumatic Fuel-Flow Control System to boost production by controlling desired fuel-flow at a constant equal rate to each end of furnace, irrespective of variations in fuel and steam pressure, temperature, or inequalities in the burner piping.

It maintains proper heat balance in checker system when furnace is reversed at periodic intervals and decreases burner coking on outgoing end of furnace by quickly closing fuel valve.

It prevents entrance of fuel after reversal until waste gas dampers are completely reversed and sufficient combustion air is supplied to burner ports.

It eliminates flooding with unburned fuel — following reversal by automatic slow opening of fuel valve at pre-determined but adjustable rate to equal rate of air delivery to the oncoming burner ports.

In plants where Brown Fuel-Flow Controllers are installed, maximum production is being attained and fuel costs are held to a minimum. To get full details about the Brown Pneumatic Fuel-Flow Control System, write for Bulletin 27-8.

BROWN *Air-o-Line* FLOW CONTROLLERS

THE BROWN INSTRUMENT COMPANY, 4464 WAYNE AVENUE, PHILADELPHIA, PENNSYLVANIA

DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

MINNEAPOLIS, MINNESOTA AND 119 PETER STREET, TORONTO, CANADA

Wadsworth Road, Perivale, Middlesex, England

Nybrokajen 7, Stockholm, Sweden

LESS COST
PER TON OF
STEEL ROLLED

Rounds

The men who do the actual rolling in the mills can tell the story of roll performance as no one else can. Ask any mill man about Pittsburgh Rolls.

PITTSBURGH ROLLS

PITTSBURGH ROLLS DIVISION of BLAW-KNOX CO.—"Steel's Partner" • PITTSBURGH, PA.

GET IT ROLLING...

KEEP IT ROLLING

with Westinghouse factory-assembled, ready-to-use control

Quickest and simplest way to get steel mill auxiliaries into action . . . and to KEEP them going . . . is with ready-to-use, factory-assembled and tested Westinghouse control. This "packaged control" is tailored to measure from standard units, and engineered for the job . . . whether the job involves control for *all* the auxiliaries in a new mill, or additions or changes in existing equipment.

Self-supporting structure eliminates need for field erection—sectional design makes it easy to add additional units. Control is shipped as a unit. You simply make incoming and outgoing connections, and the production equipment involved is ready to go into action. Write for booklet B-2265 for details and helpful application data. WESTINGHOUSE ELECTRIC & MFG. COMPANY, EAST PITTSBURGH, PA., Dept. 7-N.

Westinghouse Type SM Contactors STAY ON THE JOB

Westinghouse SM Contactors reduce number of "time-outs" because the rapid motion and quick extinction of the arc minimize burning. Contact tips are extra heavy, extra durable, easily replaceable. Bearing pins and bushings are of long-life nitrided alloy steel. Vacuum and pressure impregnated coil protected against moisture, dirt, metallic dust.

J-21154

Westinghouse
STEEL MILL CONTROL

INDUSTRIAL EXECUTIVES!

THE SCRAP FROM YOUR PLANTS IS NEEDED AT ONCE TO KEEP WAR PRODUCTION MOVING!

YOU know that all our furnaces and mills must be kept working at top speed to win this war. Yet the steel industry, already producing record quantities, cannot attain its full, needed war-time capacity of 90,000,000 tons unless 6,000,000 additional tons of scrap steel is uncovered promptly.

This critical situation can be solved only by the patriotic cooperation of every American manufacturer.

In your plant, lying around in repair shops and storerooms, is the scrap America needs to give our boys the fighting tools they must have to win . . .

Broken castings, pipe, obsolete machinery, abandoned line shafting, pulleys, pumps, old boilers, storage tanks, beams, rails, fencing, track, chains, cable, rusty bolts, nuts, and rivets . . .

Round them up and get them moving to the front!

. . . Like the gas appliance manufacturer who searched his plant and found 90 tons of scrap metals . . . or the paper mill that "mined" 1,800 tons of steel from its plants . . . or the rubber company that asked its foremen to "stop holding things" and collected 1,608 tons of iron and steel from old molds and obsolete machinery in a single week!

What others have done, you can duplicate. Walk through your plant with "Scrap" in your mind—you'll be amazed at the harvest. But get it into the fight, *at once* . . . the war won't wait!

★ ★ ★

HERE'S WHAT TO DO... Appoint one man as Salvage Manager for your organization. Give him authority to *act*—to condemn old equipment, to move material, to collect scrap of all kinds. Have him separate all scrap by type. Then move it promptly through your regular scrap dealers. Don't wait — start rounding up scrap *now* — and keep your scrap moving until the war is won!

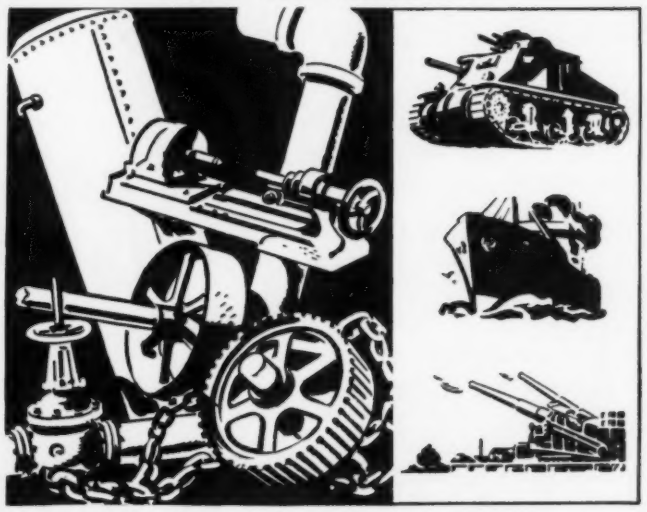
THROW YOUR SCRAP INTO THE FIGHT!

DONALD M. NELSON
says to all industry:

"The shortage of scrap materials for war production is acute. 6,000,000 extra tons of scrap iron and steel alone are needed this year, and vast quantities of rubber, copper, brass, tin, lead and zinc. Without your immediate, active cooperation — whether you have war work or not—we cannot lick this problem. We urge you to organize at once an all-out collection drive in your plants for these materials."

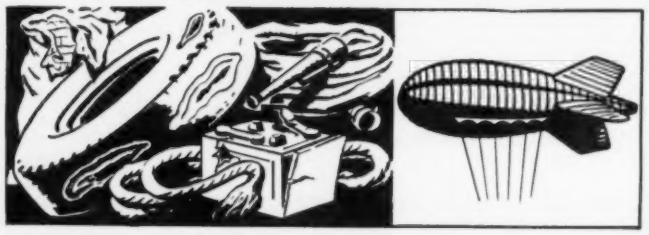
SCRAP NEEDED FOR WAR

SCRAP IRON AND STEEL



50% of every tank, ship, and gun is made of scrap iron and steel!

Other metals—Rubber—Rags—Manila rope—Burlap bags



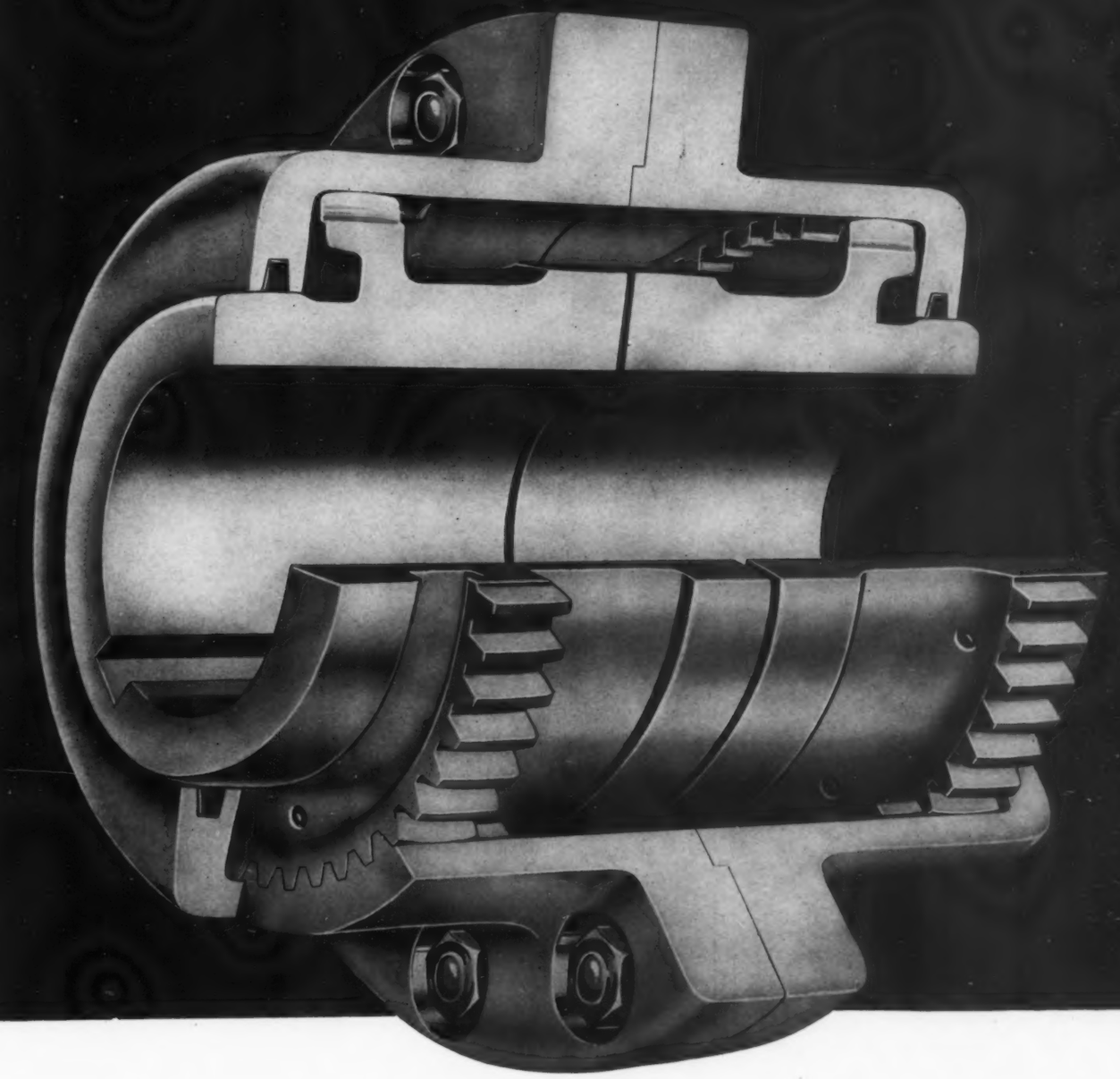
Thousands of tons of these materials are needed to make bombs, tires for jeeps, surgical supplies for military hospitals, wiping rags for guns, insulation for electric wiring, parachute flares and sandbags.

This message approved by Conservation Division

WAR PRODUCTION BOARD

This advertisement paid for by the American Industries Salvage Committee (representing and with funds provided by groups of leading industrial concerns).

POOLE



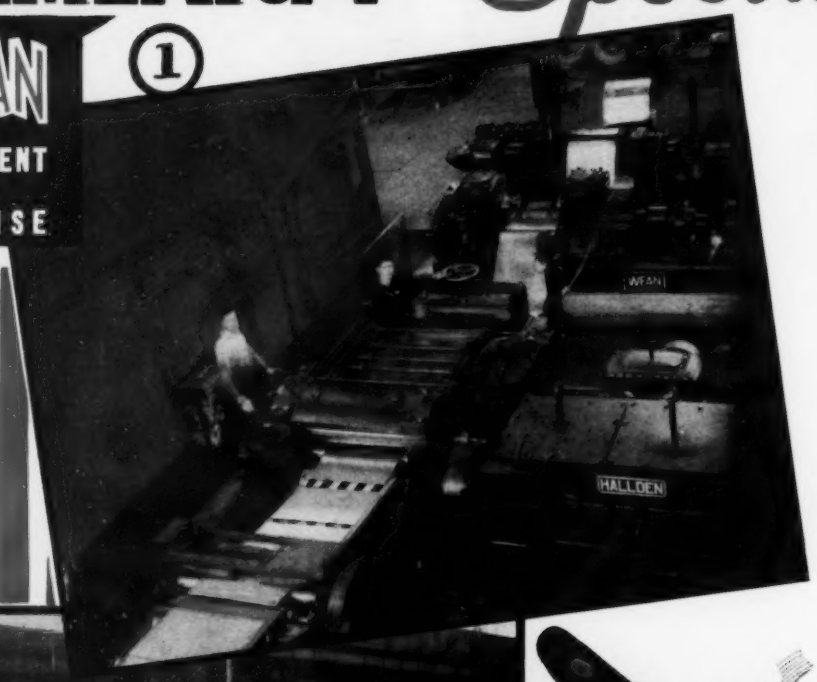
A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

AMERICA Speeds Production with WEAN

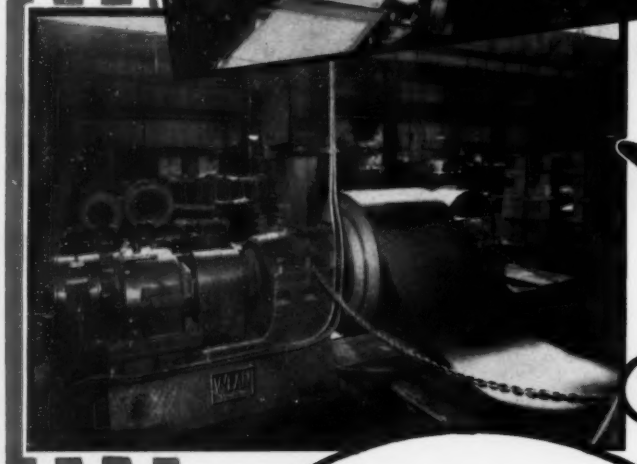
WEAN EQUIPMENT FOR OFFENSE



1

WEAN EQUIPMENT

1. Wean-Hallden Hi-Speed Tin Plate Shearing Line.
2. Wean Cone Type Hydraulic Uncoiler.
3. Wean Quick Adjusting Side Trimmer.
4. Wean Heavy Duty Roller Leveller For Armor and Ship Plate.
5. 5 Wean Automatic Hi-Speed Tin Plate Coating Lines.



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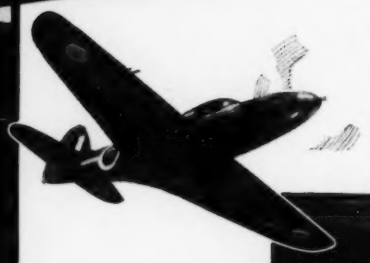

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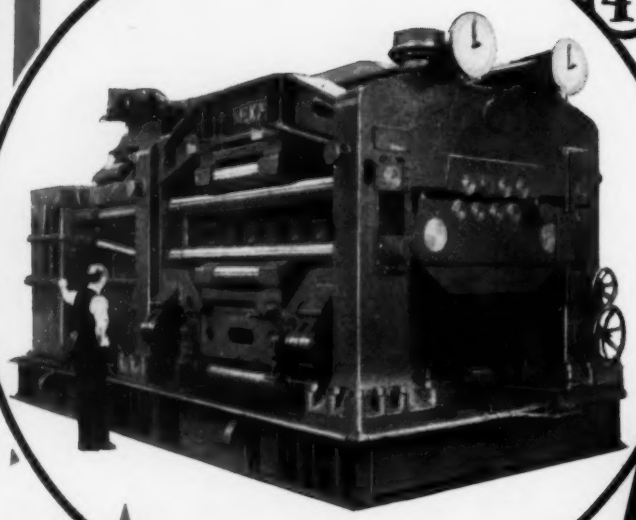

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5

The WEAN ENGINEERING CO., INC.
WARREN, OHIO

PRODUCTS:
Armor Plate Levellers . . . Shell Lathes . . . Airplane Motor Sleeve Lathes . . . Bomb Shelters . . . Tinning and Galvanizing Equipment for Light Coatings . . . Annealing Equipment for Rifle Clip Stock.

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THE HALLDEN MACHINE COMPANY, Thomaston, Conn.
THE WEAN ENGINEERING COMPANY of Canada, Ltd., Hamilton, Ontario
Subsidiary Company THE BRODEN CONTRUC CO., Cleveland, Ohio Manufacturers of Strip and Wire Mill Mach

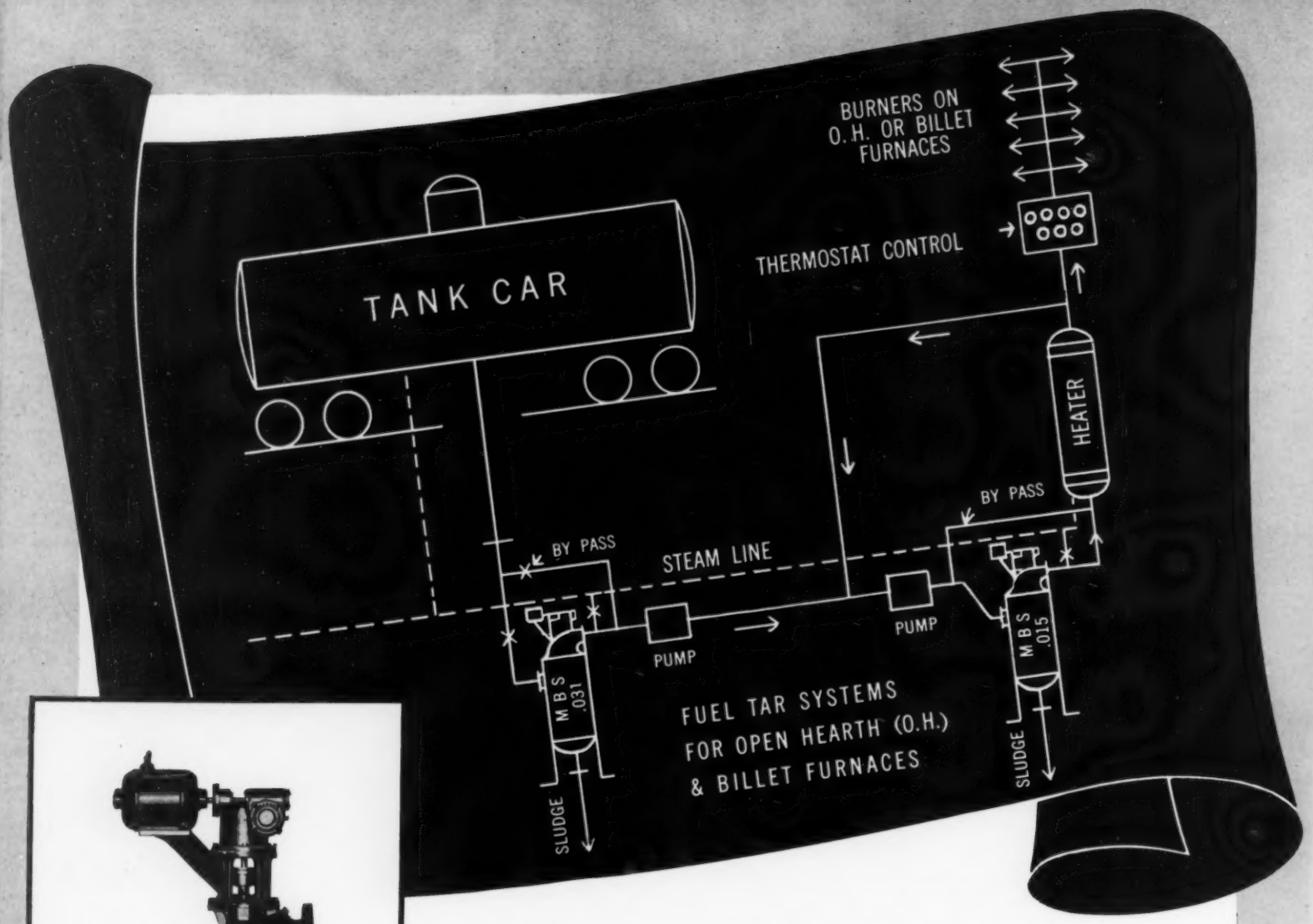
Lewis ROLLS

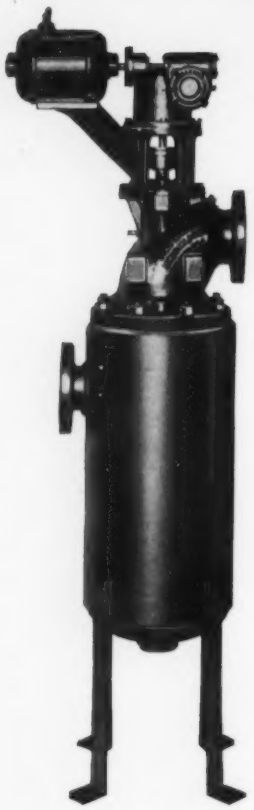
BETTER FINISH INCREASED TONNAGE

Lewis Plate Mill Rolls are providing extra tonnages for the production of vital armament.

LEWIS FOUNDRY & MACHINE
DIVISION OF BLAW-KNOX CO.
PITTSBURGH, PA.

Also manufacturers of
ROLLING MILL MACHINERY
for the iron, steel and non-ferrous industries





KEEP FLOW ON "GO" WITH

CUNO

THE "FILTER-FINE" STRAINER

CUNO SMOOTHES FLAME

by removing solids from fuel tar used to fire open hearth furnaces

Refractory lime and other solids present in fuel tar clogged up burner nozzles, metering apparatus and even the 4-inch feed lines.

Various filtering devices involved frequent shut-downs for cleaning — obviously undesirable in a fuel supply. And the service seemed too severe for self-cleaning filters.

But experiments were made with Cuno Filters, having a permanent all-metal filter element from which accumulated solids can be removed *while* fluid flow continues. The experiments led to the installation of two Cuno Auto-Klean Filters; one a primary roughing filter (.031″) on suction side of storage tank pump; and a fine filter (.015″) in the recirculating system which keeps the tar hot and free-flowing. Results:

- Complete freedom from clogging
- No more flame fluctuation
- Nozzle reduced in size for higher efficiency
- Unimpaired operation of meters
- Adoption of thermostatic control

Investigate Cuno for all kinds of fluid cleaning. A free bulletin, "Quick Facts," describes the Auto-Klean, recommended for lubrication and fuel systems, and the backwash-type Flo-Klean to handle descaling spray, coolant and hydraulic systems. Send for it.

CUNO ENGINEERING CORPORATION

909 SOUTH VINE STREET, MERIDEN, CONNECTICUT

Micromax Records Results of Heat-Flow Computer

Time and effort needed for heat-transfer computations are reduced—usually much reduced—by an electrical computing circuit now in Columbia University's M. E. Department.

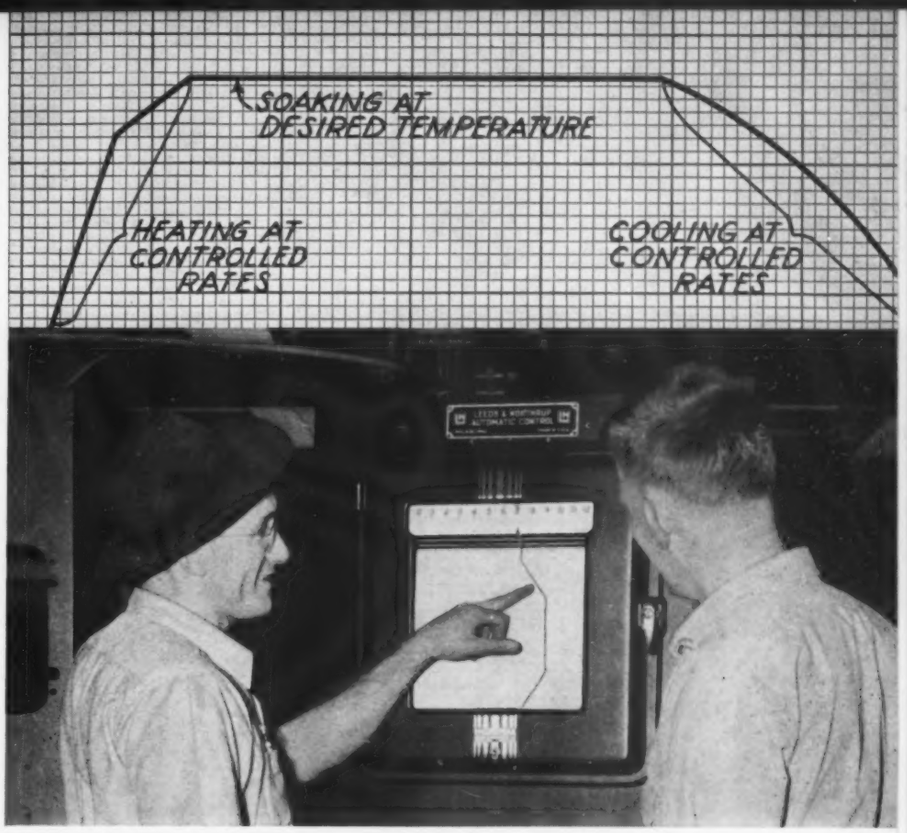
Dr. Victor Paschkis at the operating bench of the heat-flow computing "model" in Columbia University's Dept. of Mechanical Engineering. The big recording machines are Micromax instruments, which give final temperatures in heat-flow measurements.

Developed by Dr. Victor Paschkis, the equipment consists of resistors and condensers, so arranged that they can create a low-inductance circuit.

In this circuit, current behaves much as heat does in a furnace or building wall, or other object. As it flows, some of it remains to "fill" any condensers in its path, while the rest continues; just as heat "fills" anything in its path through a solid conductor. The analogy is such that the designer can create a "model" of a contemplated heat-transfer equipment simply by substituting electrical quantities for thermal ones. Thus, thermal conductivity is represented by electrical capacity; temperature, by voltage. Btu's become coulombs, and Btu's per hour become amperes. And duration of heat flow, which may be hours or days, can be represented by minutes of current flow. Or, a process which occurs in seconds or fractions, may be stretched, to facilitate analyses.

The net results of the circuit's operation are shown by various instruments, perhaps the most important of which are a pair of Micromax Recorders. These instruments record the voltages which correspond to temperature, just as similar instruments record thermocouple voltages elsewhere.

Applications of the equipment include problems in heating, quenching, and cooling of metals, glass, chemicals, cement, coal, etc.; design of buildings, vessels, refrigerators, and furnaces; applications in the food industries, in prime-mover design, brakes and clutches, and elsewhere. The method is described in Vol. 64, No. 2, *Trans. ASME;* in May, 1941 *Power* and in July '42 *ASHVE Jrl.*



Micromax Program Controller comes to you on a completely-wired panel, ready to connect to the process equipment . . . Above: Schematic curve, typical of thousands of temperature-paths which Micromax can compel a product to follow.

"TEMPERATURE-BENDING" MICROMAX Saves Process-Control Time

The time which workmen spend in regulating the *heating* and *cooling* of ovens, kettles, furnaces, etc., can now be saved, in many plants, by "temperature-bending" Micromax Program Controllers.

Program Control regulates the rates of heating and cooling, as well as the maximum or soak temperature. It is one of the newer ideas, now drafted by war industries to help secure the fast, accurate heat-treatment required by so much war matériel. Under it, the Micromax is set when the process is still cold. The temperature increases at any desired rate or rates, "bends" when it reaches the soak temperature, holds the soak as long as is specified, and "bends" down again in a controlled cooling cycle.

Control during heating and cooling is just as rigid as during the soak. Outside temperature, fuel pressure, air supply, etc., may change, but the Micromax meets every shift with correct action. Control can be either on-off, or "throttling" (proportional-positioning and floating), which acts continuously as a good man would act. Or, it may switch from one type of control to the other.

In this strenuous service, Micromax acts with superior speed-plus precision, even before the fluctuations are big enough to show on the chart. And the accuracy of its response is guarded by the self-standardizing characteristic of the pyrometer; by its rugged, low-maintenance construction; by its long-sustained reputation as a fully dependable controlling machine. Micromax is available in 5 models and hundreds of ranges, for handling temperatures of below-zero to above-thermocouple proportions. To receive general information, ask for Catalog N-33A; for specific engineering service, outline your problem.

Jrl Ad ENT-0600C(51)

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

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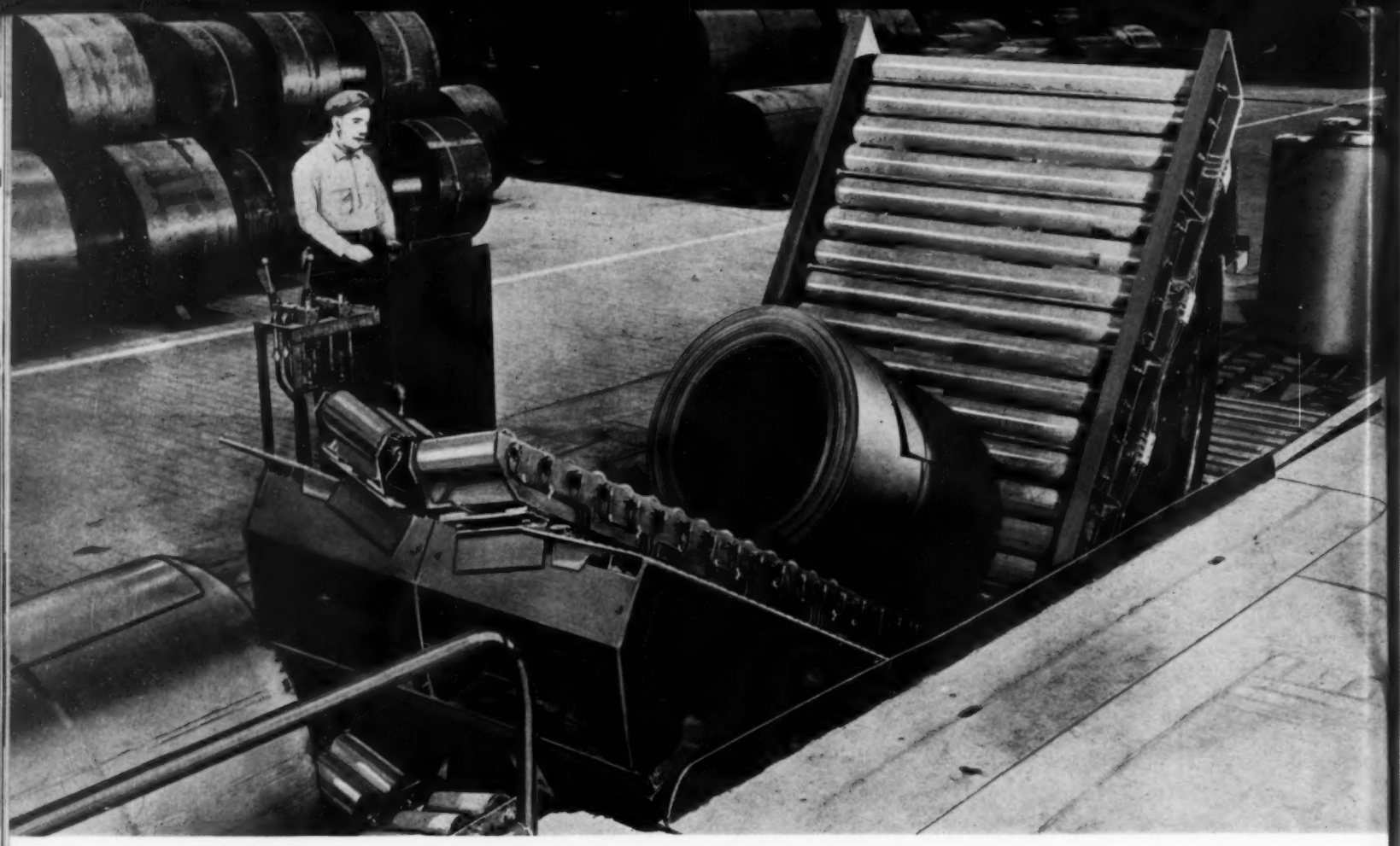
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES



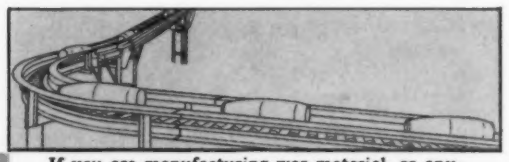
SPEEDING AMERICA'S PRODUCTION

The success of the Allied war effort depends greatly upon the speed of our production — the output of coils and sheets, castings and forgings, bars and shapes — and thousands of other vital materials. American Industry has already come through in a way that spells disaster for the Axis nations, and it's only the beginning.

Mathews Engineers are spending long hours in solving the many conveying problems which go along with this great production program. You can get Mathews engineering service and Mathews Conveyers with much less delay than you might think. By furnishing the highest preference rating you can possibly obtain, along with complete information regarding your problem, much time can be saved in obtaining the conveying equipment you require. Our job is to serve you in the most efficient manner possible.

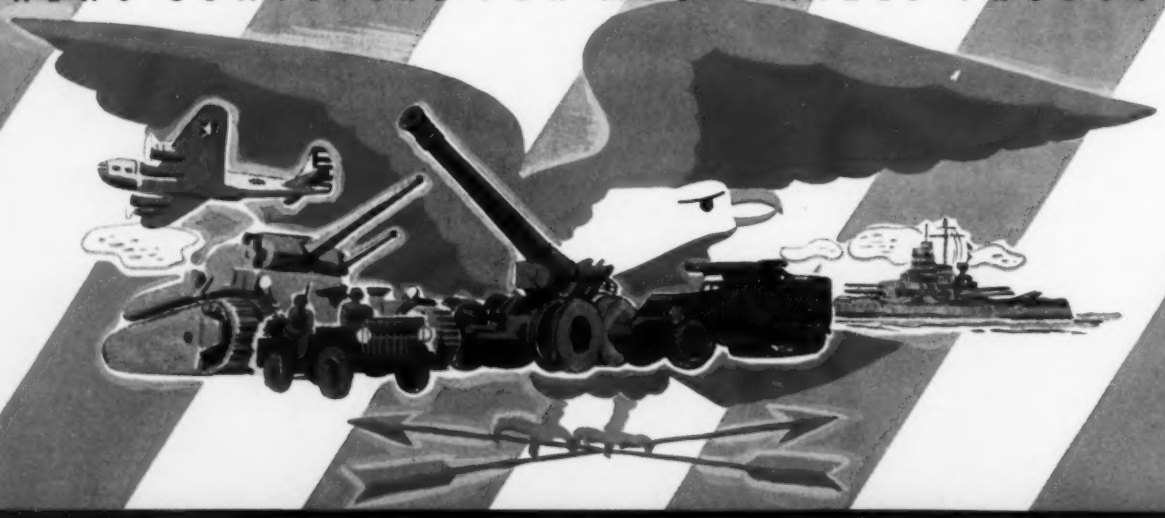
MATHEWS CONVEYER CO.

ELLWOOD CITY, PENNSYLVANIA



If you are manufacturing war material, or anything vital to the success of the war effort, you can get Mathews Conveyers to handle that material Rely as usual on your Mathews Engineer.

MATHEWS CONVEYERS FOR MECHANIZED PRODUCTION



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IRON AND STEEL ENGINEER

SEPTEMBER • 1942
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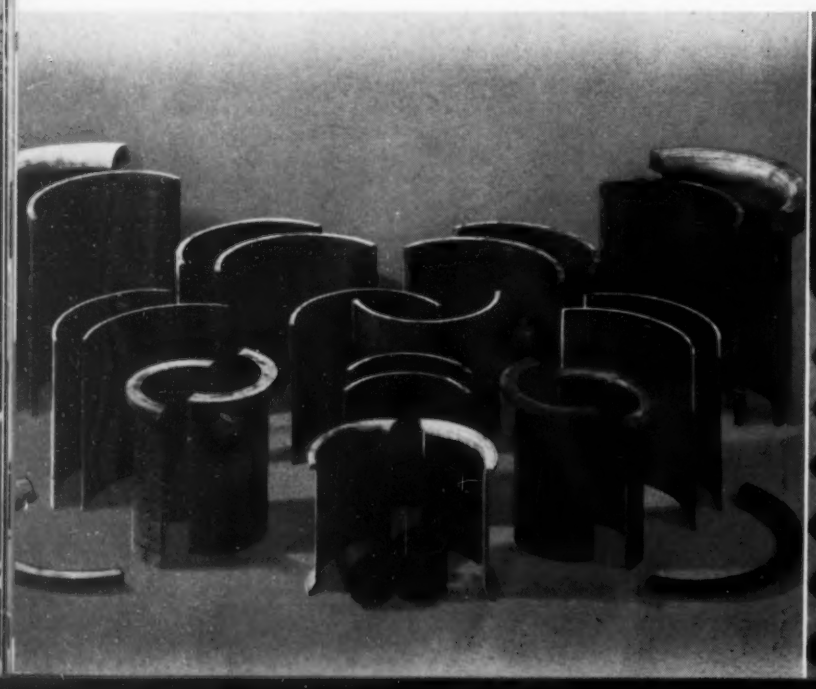
Help Conserve oil grease and Restricted Metals

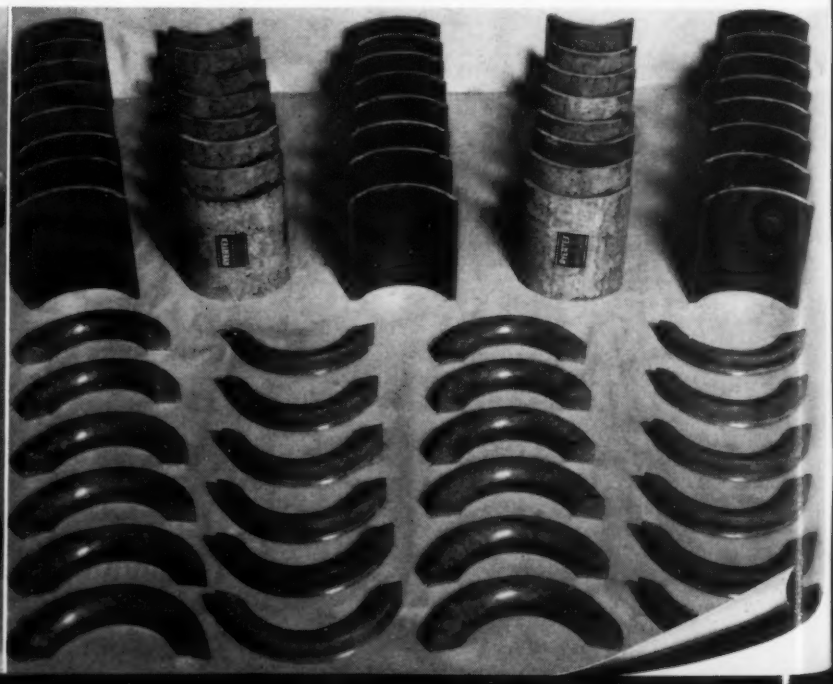
Use Ryertex Bearings

— they're Non-metallic and Water-lubricated

In addition to substantial savings in lubricating materials, mill operators all over the country report that Ryertex Bearings reduce power consumption, increase tonnage, lower maintenance costs, and give longer bearing life.

Whatever your bearing problems—whether they concern roll necks, spindle carriers or roller twist guides—call in a Ryertex engineer. He is familiar with many applications in many different types of mills and will be glad to work with you on your particular problem. Joseph T. Ryerson & Son, Inc. Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Philadelphia, Buffalo, Boston, Jersey City.





MOTOR Applications and POWER Requirements for Strip Processing Lines

. . . . a pioneering effort to set forth data on the application of drive motors to miscellaneous strip processing equipment . . . .

By H. W. Poole, STEEL MILL SECTION

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▲ CONSIDERABLE data have been accumulated and several papers have been written on the power consumption of hot and cold strip mills; however, very little has been published and comparatively little power data have been accumulated for strip processing lines. The industry is constantly asking for recommendations regarding types and capacities of motors and motor-generator sets as well as control equipment for these lines, and in order to be able to make such recommendations with a reasonable degree of accuracy it is essential that we have available as much basic data as possible with convenient means of applying these data to varying conditions.

It is the purpose of this paper to approach the subject of power requirements for the various processing lines from the standpoint of the correct size, type, and form of motor to be applied for doing specific jobs and the determination of suitable motor-generator set capacities rather than from the standpoint of energy consumption in kwh per ton. Although it is not feasible to present data on all of the types of complete processing lines in use today, the results obtained for various individual

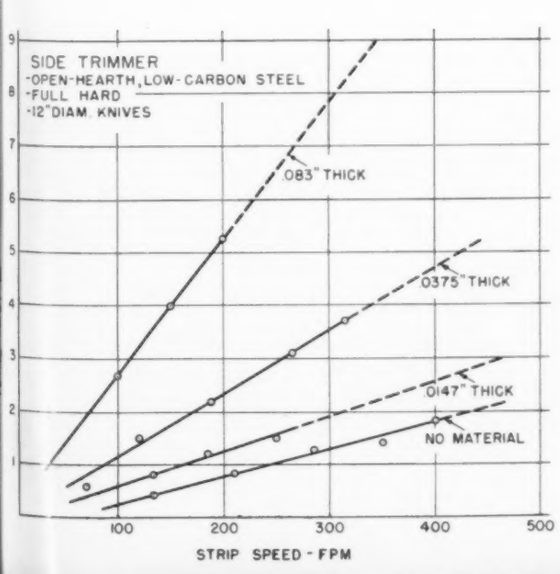

Figure 1 — Tests on side trimmer showing horsepower required at various speeds to side trim full hard steel strip.

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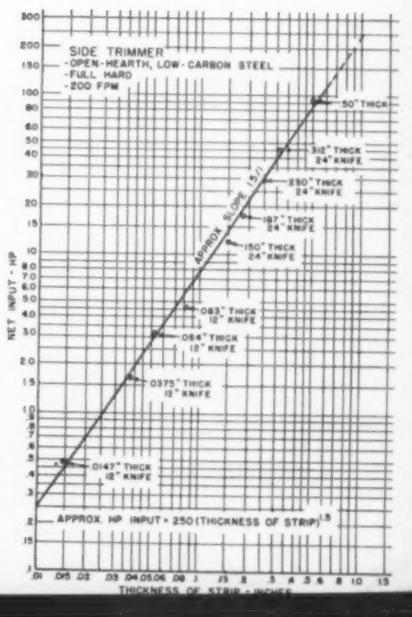
Figure 2 — Curve showing relationship between strip thickness and horsepower required to side trim steel strip at constant speed.



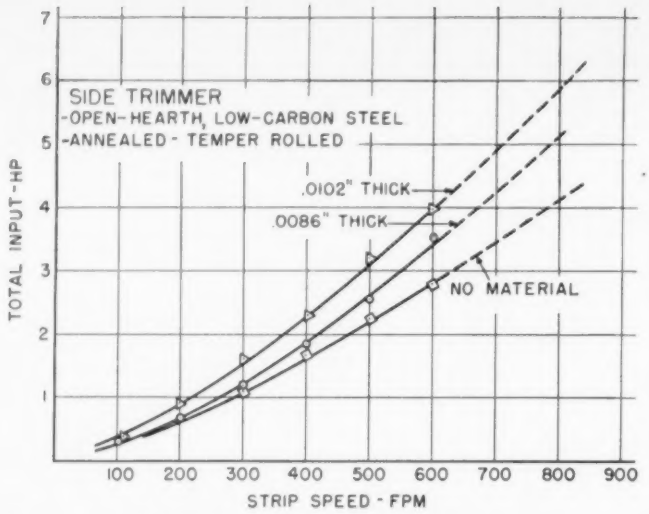


Figure 3 — Tests on side trimmer showing horsepower required at various speeds to side trim annealed steel strip (tinplate).

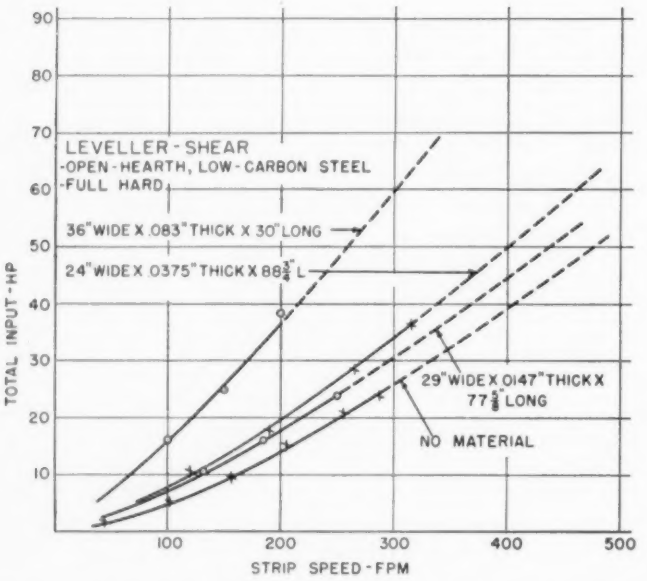

LEVELLER - SHEAR
-OPEN-HEARTH, LOW-CARBON STEEL
-FULL HARD
36"WIDE X .083" THICK X 30" LONG
24"WIDE X .0375" THICK X 88¾" L
29"WIDE X .0147" THICK X 77⅝" LONG
NO MATERIAL
TOTAL INPUT - HP
STRIP SPEED - FPM

Figure 4 — Tests on 2-high, 10-roll leveler-shear (rocking type) showing power required for full hard steel strip.

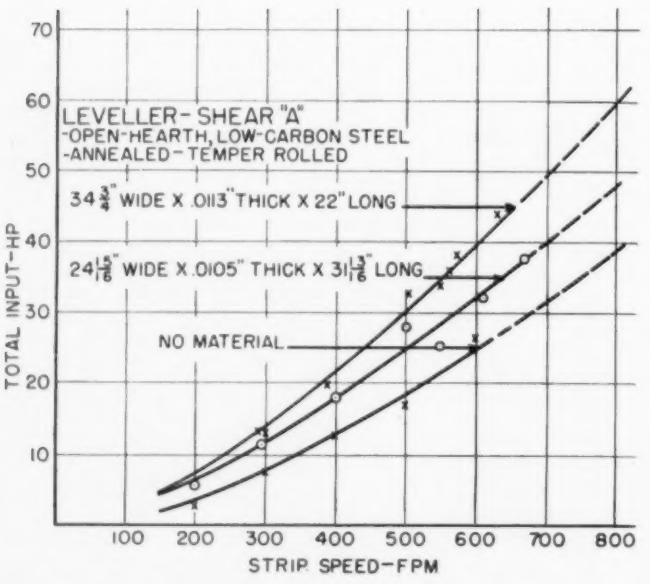

LEVELLER - SHEAR "A"
-OPEN-HEARTH, LOW-CARBON STEEL
-ANNEALED - TEMPER ROLLED
34 3/4" WIDE X .0113" THICK X 22" LONG
24 15/16" WIDE X .0105" THICK X 31 13/16" LONG
NO MATERIAL
TOTAL INPUT - HP
STRIP SPEED - FPM

Figure 5 — Tests on 2-high, 17-roll leveler-shear (drum type), showing power required for annealed steel strip (tinplate).

drives can be combined into different groups such as comprise many of the most common complete lines.

The data on which the curves and conclusions in this paper are based represent tests made on over 60 individual drives in ten major steel plants. Since it was not possible to make complete tests on all of the different types of strip processing equipment and all of the different products for which such equipment is designed, it seemed advisable to concentrate upon the most common drives in order to obtain as much data as possible on certain ones.

The curves of horsepower versus strip fpm represent, in most cases, horsepower input to the driven machine and were obtained by calculations based upon volt and ampere readings of input to the armature of the driving motor. In all such cases the motor fields were excited from a separate source and remained reasonably constant so that the field excitation did not enter into the calculations.

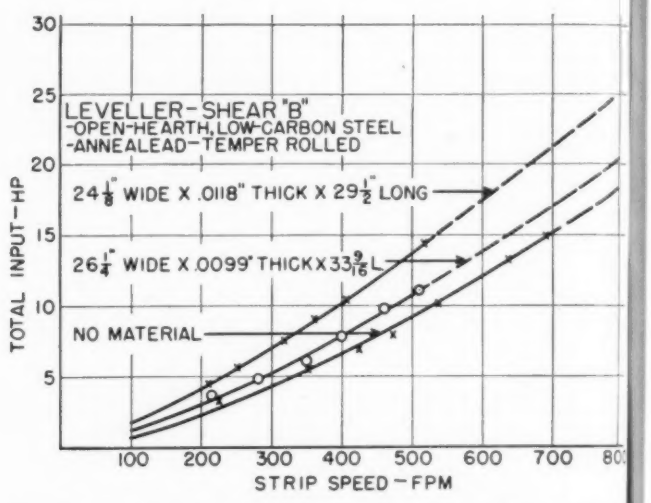

LEVELLER - SHEAR "B"
-OPEN-HEARTH, LOW-CARBON STEEL
-ANNEALEAD - TEMPER ROLLED
24 1/8" WIDE X .0118" THICK X 29 1/2" LONG
26 1/4" WIDE X .0099" THICK X 33 9/16" L
NO MATERIAL
TOTAL INPUT - HP
STRIP SPEED - FPM

Figure 6 — Tests on 2-high, 17-roll leveler-shear (drum type), showing power required for annealed steel strip (tinplate).

In order to show the method of computing horsepower input to a driven machine from readings of kw input to the motor, a set of calculations for one group of readings taken on a side trimmer will be shown. In all other cases, only the resulting curves and conclusions are presented.

The following information will be divided into three major parts as follows:

Part I — Typical test curves and conclusions based upon tests for various individual drives.

Part II — Application of motors and motor-generator sets for processing lines in general.

Part III — Selection of motors and motor-generator sets for several common types of strip processing lines.

Side Trimmers and Slitters

The side trimmer represents a very common type of machine used in the modern processing line. Figure 1 shows typical curves of strip fpm plotted against horse-

power input to a side trimmer forming a part of a typical sheet shearing line.

The curve labeled "no material" represents the running light losses of the driven machine only, since the motor losses have been subtracted. As a matter of convenience, the running light losses of the driven machine will be spoken of as friction although it is recognized that other factors may be involved. By subtracting the friction horsepower from the total horsepower required for any given thickness and speed, the net horsepower required to do the actual work may be obtained. It is recognized that the losses of the driven machine may increase somewhat due to bearing loading when the strip is in the knives, but with the present day use of anti-friction bearings this increase will be very small and for all practical purposes can be neglected.

Table I is a tabulation of the various readings and calculations upon which the curves in Figure 1 are based. For any given speed and current the total loss is subtracted from the total input to give the motor output, i.e., input to the driven machine. The top horizontal line gives the rated speed and current of the driving motor with the various current losses and speed losses taken from design data. The motor current losses consisting of commutating field, armature, series field, and brush I^2R were assumed to vary approximately as the square of the armature current and were calculated as such for each value of current. The motor bearing friction and windage losses were considered to vary approximately as the 1.5 power of the speed, the core loss as about the 1.5 power of the speed, and the brush friction directly as the speed. Such assumptions regarding current and speed losses are not close enough for designing engineers, but are close enough for the purpose of application engineering and give more accurate results than can be obtained by estimating the motor efficiency at each speed and load.

Figure 2, which has been plotted on log-log paper, shows the relationship between thickness of strip and net horsepower required to side trim at a constant strip speed of 200 fpm. The readings which serve as a basis for this curve represent tests on three different side trimmers located in different steel plants, all cutting open hearth, low carbon, full hard steel. The location of the various test points and the slope of the curve indicate that for all practical purposes the diameter of the knife does not affect the horsepower required, and that for any given strip speed the net cutting power increases approximately as the 1.5 power of the thickness.

Figure 2 is useful in that the net horsepower required for various thickness, at the speed upon which the curve is based, can be read directly from the curve, or the slope of the curve can be used as a factor for obtaining the net horsepower required for any thickness.

For example, let us assume that we wish to know the net cutting power required to side trim 0.4 in. open

TABLE I

Calculation of Motor Output from Test Readings

Motor readings				Calculated losses — watts					Calculated motor output	
Rpm	Volts	Amps	Input watts	Current loss	Brush friction	Windage and brg. friction	Core loss	Total	Watts	Hp
1150	230	74	17020	862	73	250	487	1672	15348	20.6
515	90	6.5	585	6.5	33	88	146	273.5	311	.42
805	140	8	1120	10	51	146	284	491	629	.84
1095	190	8.5	1615	11.5	70	232	453	766.5	848	1.14
1350	232	9	2088	12.5	86	317	620	1035.5	1052	1.41
1545	262	10	2620	15.5	98	389	757	1259.5	1360	1.83
510	95	9	855	12.5	32	73	144	261.5	593	.8
710	130	10	1300	15.5	45	121	236	417.5	882	1.2
960	175	10	1750	15.5	61	190	372	638.5	1112	1.5
270	48	12	576	25	17	28	56	126	450	.6
460	88	15	1320	35	29	64	123	251	1069	1.5
720	132	16	2112	40	46	124	242	452	1660	2.2
1020	180	17	3060	45.5	65	209	410	729.5	2331	3.1
1210	210	17.5	3675	48	77	269	510	904	2772	3.7
385	82	28	2296	124	24	48	94	290	2006	2.7
575	123	28	3444	124	37	88	172	421	3023	4
770	160	28	4480	124	49	121	267	160	3919	5.25

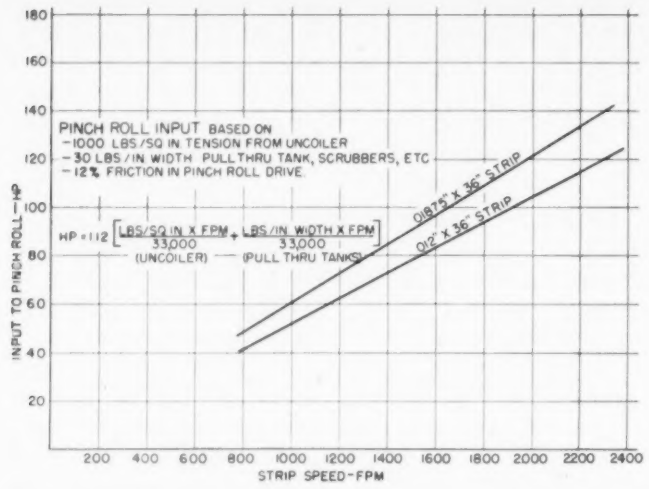

PINCH ROLL INPUT BASED ON
-1000 LBS/SQ IN TENSION FROM UNCOILER
-30 LBS/IN WIDTH PULL THRU TANK, SCRUBBERS, ETC
-12% FRICTION IN PINCH ROLL DRIVE
HP = 1/12 [LBS/SQ IN X FPM / 33,000 (UNCOILER) + LBS/IN WIDTH X FPM / 33,000 (PULL THRU TANKS)]
0.875" X 36" STRIP
0.12" X 36" STRIP
INPUT TO PINCH ROLL - HP
STRIP SPEED - FPM

Figure 7 — Curves for selection of drag generators for uncoilers.

hearth, full hard steel at 200 fpm. From Figure 2, we see that:

Approximate net hp input = 250 [thickness (in.)]$^{1.5}$ Substitution in the formula gives an answer of approximately 63 net hp, which checks with a similar value that can be read directly from the curve. It should be recognized that this represents net cutting power only and that a suitable allowance must be made for the power required to run the trimmer without strip.

Similar data were obtained on side trimmers for annealed, temper rolled tinplate strip; however, the friction in this case forms such a large part of the total cutting load that the chance of error is very great in attempting to determine the net cutting power or in comparing with other data. The results of one typical test are shown in Figure 3 in order to give a general idea of the power required for typical tinplate gauges.

Although Figure 1 did not indicate that either the net cutting power or the "friction" power increased appreciably faster than the speed, Figure 3 shows both increasing as about the 1.3 power of the speed. Furthermore, the majority of side trimmers indicated a somewhat similar trend and it would, therefore, appear that in estimating the power required at various speeds this factor should be taken into account.

Slitters, of course, are in the same general classification as side trimmers and while no results are available for presentation here, the results obtained for side trimmers can be utilized for slitters with a satisfactory degree of accuracy by taking into account the relative number of cuts of the metal.

Levelers and Leveler-Shears

Two other very common types of processing line drives are the leveler and the combined leveler-shear. Inasmuch as the power required for such drives is affected greatly by the diameter of the leveling rolls, the general design of the machine, and the relative position of the work rolls, it is difficult to formulate any "yard stick" which can be applied at random. Furthermore, in order to obtain satisfactory comparative data even on one machine, it is necessary to make complete tests with various "hand-picked" combinations of strip gauges, widths, and lengths as well as various settings of the levelling rolls.

Obviously, such tests cannot be made without taking the machine out of normal service and since no steel company can afford to lose the output of an entire processing line at the present time or to furnish operators for such tests which cannot be made in conjunction with normal production, conclusive tests are not available. However, as a matter of interest, some test curves made on several leveler-shears during normal production are included.

Figure 4 shows the power required in one instance to level and shear low carbon, full hard steel in typical sheet sizes on a 2-high, 10-roll leveler with 3.8 in. work rolls and a "rocking" type flying shear. Here, also, the power required with and without material increased at a faster rate than the speed.

Figure 8 — Curves for selection of pinch roll motors.

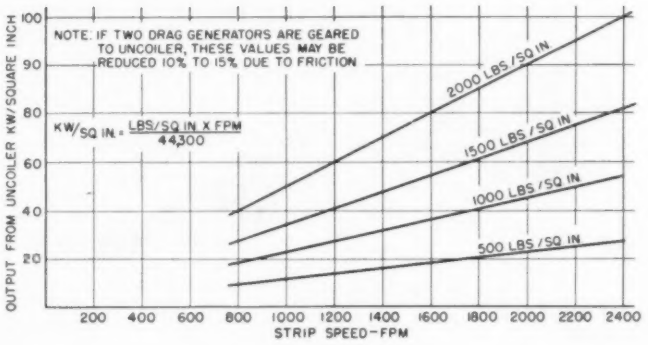

NOTE: IF TWO DRAG GENERATORS ARE GEARED TO UNCOILER, THESE VALUES MAY BE REDUCED 10% TO 15% DUE TO FRICTION
KW/SQ IN. = LBS/SQ IN X FPM / 44,300
2000 LBS/SQ IN
1500 LBS/SQ IN
1000 LBS/SQ IN
500 LBS/SQ IN
OUTPUT FROM UNCOILER KW/SQUARE INCH
STRIP SPEED - FPM

Figure 5 shows the power required for ordinary tinplate strip being processed on a 2-high leveler with 2.5 in. work rolls and a drum type flying shear. Shear "A" as shown on Figure 5 requires approximately 32 hp to level and shear tinplate 24 15/16 in. wide × .0105 in. thick × 31 13/16 in. long at 600 fpm. Of this 32 hp, approximately 25 hp represents friction thus leaving 7 hp as the net load.

Shear "B" as shown in Figure 6 requires approximately 17 hp to level and shear tinplate 24 1/8 in. wide × .0118 in. thick × 29 1/2 in. long at 600 fpm. Of this 17 hp, only 12 hp is friction and the net load is 5 hp.

Here, as in the case of the side trimmer for tinplate gauges, the friction represents such a large portion of the total power that the net load readings are not accurate enough to be used for comparative purposes, but the curves do indicate typical readings and show that wide differences in friction loads may exist between different designs of leveler-shears.

Uncoilers (Without Tension)

Many processing lines, especially side trimming and

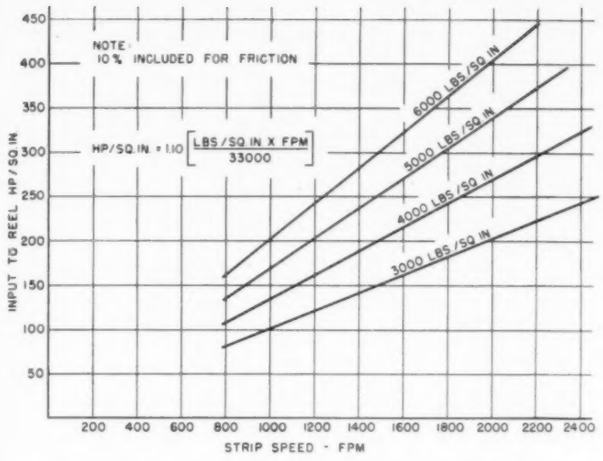


Figure 9 — Curves for selection of reel motors.

shearing lines, use motor driven uncoilers which operate with a loop between the uncoiler and the following machine. In such cases, the motor supplies only the power to rotate the coil. This power increases slightly faster than the speed and is affected somewhat by the weight of the coil.

Numerous tests made on trimming and shearing lines operating up to 750 fpm with coils weighing as much as 6000 lb and gear ratios as high as 28.3/1, showed that in no case was over 3 hp input to the uncoiler required at top speed of the line and in most cases this was less than 2 hp.

It must, of course, be appreciated that the heaviest duty is imposed on the driving motor during acceleration and deceleration and that during these periods the armature current often reaches a peak value of three or four times the normal running value. For this reason it is necessary to select the motor on the basis of the WR^2 and required rate of acceleration as well as the friction load.

Uncoilers (With Tension)

Some sheet shearing lines and many electrolytic cleaning lines operate in conjunction with electrical drag generators on the uncoilers in order to maintain back tension. It is possible to calculate the kilowatt output required from the drag generator in order to maintain the desired tension at a given speed and this output will, of course, vary directly with strip speed. Furthermore, if we neglect friction, the output of the drag generator will remain constant over the range of coil build-down for a given tension and strip speed.

Tests made on several different high speed cleaning lines indicated that an average uncoiling tension of from 1000 to 1300 psi was being maintained. In one extreme case, the operator was maintaining a tension of 2400 psi, but this was unnecessary and a readjustment of the tension gave equally satisfactory results.

The tension being held was not due entirely to the action of the drag generator or generators inasmuch as the friction tended to supply part of the tension. In those cases where two drag generators were used, the friction accounted for approximately 15 per cent of the tension in the strip; whereas, in one case where tests were made with only one drag generator, the friction accounted for slightly less than 7 per cent of the average tension being maintained.

The curves in Figure 7 are plotted as output from the uncoiler in kw per square inch of strip against strip fpm. These curves are plotted for various values of tension in the strip and may be used to read directly the kw required to maintain a given value of tension at a given strip speed. If two drag generators are geared to the uncoiler, these values should be reduced from 10 to 15 per cent in calculating the required kilowatt rating of the drag generators.

Pinch Rolls

In order to pull the strip off the tension uncoiler and propel it through the various processing drives, motor driven pinch rolls are quite often used. While it was not possible to make tests on all of the different types of pinch rolls in use, several tests were made on pinch rolls operating on electrolytic cleaning lines in conjunction with the tension uncoilers just mentioned. The running light or friction losses of the pinch roll depend to some extent upon the pressure exerted on the rolls; however, these losses averaged approximately 12 per cent and in no case exceeded 16 per cent of the total output of the pinch roll motor. In addition to supplying the friction losses and overcoming the tension as produced by the uncoiler, the pinch roll motor must also pull the strip through the various tanks, dryers, scrubbers, etc. In order to determine just how much pull was required to propel the strip through the average cleaning line, the tension produced by the uncoiler was subtracted from the net input to the strip from the pinch roll. A comparison based upon the relative width of the strip in each case showed that from 25 to 35 lb per inch of strip width was exerted by the pinch rolls in pulling the strip through the tanks in addition to overcoming the tension produced by the uncoiler.

In order to give some idea of what the foregoing means in the way of power, the curves in Figure 8 have been plotted to show the input to a pinch roll based on 1000 psi tension produced by uncoiler, 30 lb pull per inch of width due to tanks, scrubbers, etc. and approximately 12 per cent friction. The formula shown on Figure 8 can be used for plotting similar curves for various other conditions.

Tension Reels

Another very common drive on modern strip processing lines is the winding or tension reel. As in the case of the uncoiler, if we neglect friction, the power required to maintain a given strip tension at a given speed is constant. Tests made on the winding reels of several electrolytic cleaning lines indicated that an average strip tension of 4000 psi was being maintained and in most cases friction amounted to only about 10 per cent of the total input to the reel.

Here again the load on the motor is heaviest during acceleration and deceleration, but unlike the uncoiler

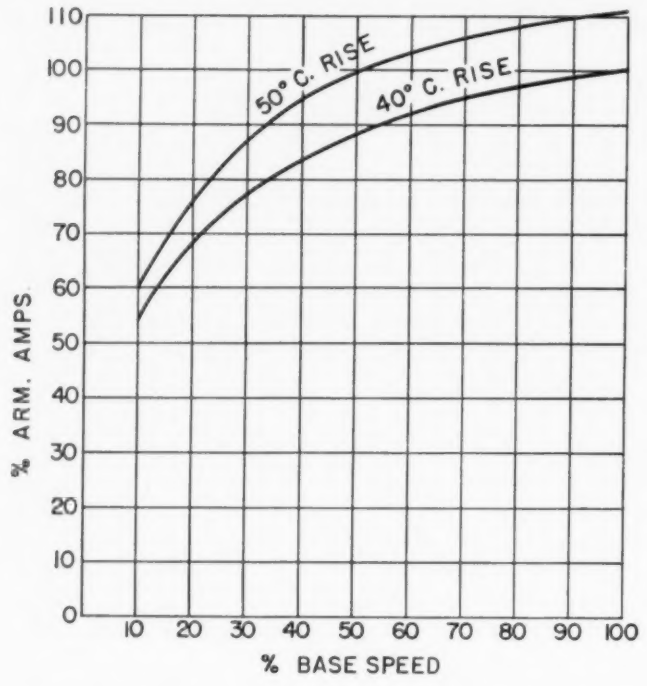


Figure 10 — Characteristic curves showing reduced current carrying capacity of d-c motors at reduced speed and voltage, full field.

which operates with a loose loop, the strip tension accounts for the major portion of the normal running load. Consequently, even though the winding reel and uncoiler on a given processing line must frequently accelerate the same WR^2, the accelerating load is a much smaller proportion of the normal running load on the tension reel motor; and in most cases it is not necessary to increase the motor size to take care of accelerating peaks.

It should be noted that the winding reels on which these tests were made were associated with cleaning lines having a rated speed of 1200 fpm and over. Obviously, as the rated speed of the line drops, the total horsepower required becomes less to do a given job and the friction becomes a greater part of the total horsepower. This was forcibly brought out by tests made on one slow speed continuous plating line where with a maximum strip speed of 100 fpm, a strip width of 16 in., and a reel gear ratio of 56/1, the friction amounted to approximately 50 per cent of the normal input to the reel. Of course, this is an extreme case but serves to illustrate that friction becomes a very important factor on slow speed lines where the gear ratios are relatively high and where the power required for normal strip tension is low.

In order to give a convenient means of determining the approximate horsepower required for a given speed and strip tension on the winding reel of a high speed electrolytic cleaning line or similar line, the curves in Figure 9 have been plotted as horsepower per square inch of strip against strip fpm. In plotting these curves, a factor of 10 per cent of the total input to the reel has been allowed for friction, but this will, of course, vary with the gear ratio, type of bearings, and other miscellaneous factors.

Bridle Rolls

In order to give a source of back tension against which the winding reel can pull, many processing lines of different types use one and sometimes two drag generators connected to the bridle rolls. These bridle rolls operate in conjunction with the winding reels much in the same way that the tension uncoiler operates in conjunction with the pinch rolls, except that there are usually no miscellaneous scrubbers, etc., in between the bridle rolls and the tension reel. Because of this, the bridle rolls must regenerate enough power to account for all the winding tension in the strip exclusive of the friction in the bridle stand itself.

No tests are available on bridle rolls with direct connected drag generators on each roll, however, several tests were made on the type of bridle stand where a drag generator is geared to both rolls. The results indicated that the output of the bridle roll drag generator was approximately 80 per cent of the output of the reel motor. This, of course, means that approximately 20 per cent of the reel motor output is accounted for in friction of the reel and of the bridle stand itself. In one instance, the output of the bridle roll drag generator accounted for only about 70 per cent of the input to the reel motor; however, this was due to the fact that a friction drag was being used in conjunction with the bridle rolls.

Under average conditions where a single drag generator is geared to the two rolls, the motor can be given a horsepower rating equal to 80 per cent of the reel motor rating or preferably can be given a kilowatt rating of 60 per cent of the horsepower rating of the winding reel motor. In those cases where individual drag generators are direct connected to each roll, the friction of the bridle stand is undoubtedly decreased appreciably and this fact should be taken into account when selecting the correct drag generator size or sizes in such cases.

It is recognized that some of the power input to reel goes into bending the strip as well as into producing tension and while this may not be appreciable in the case of tinplate gauges, it is quite possible that for much heavier gauges the bridle roll drag generator can be made relatively smaller with respect to the reel motor.

Application of Motors and Motor-Generator Sets

While the foregoing curves of horsepower versus speed give typical power requirements for various common types of processing line drives, these curves cannot always be used to directly select the size of the motor to be applied for a specific job. Most of the processing lines use adjustable voltage control and in doing so, the motors operate for varying periods of time at less than rated speed.

Because of this reduced speed operation, the inherent self-ventilation of the open or protected motor is reduced and its current carrying capacity at low speed is less than at rated speed. For example, a 50 hp open motor cannot develop 25 hp continuously at one-half of rated speed and remain within its rated temperature

Figure 11 — Photograph of continuous tinplate shearing line.

rise. Curves shown on Figure 10 are representative of the loads which can be carried continuously at reduced speed without exceeding rated temperatures or without exceeding safe temperatures when open or protected self-ventilated motors are used.

For example, the curves indicate that for continuous operation at 10 per cent of rated speed, the motor armature current normally should not exceed 55 to 60 per cent of its rated current.

It is recognized that motors of the totally enclosed, non-ventilated type depend almost entirely upon radiation to dissipate the heat and that this radiation is not appreciably affected by reduced speed operation. As a result, the totally enclosed, non-ventilated motor is quite often used where excessively wide speed ranges are involved.

Fortunately, the large majority of the tests made on side trimmers, levelers, leveler shears, and such drives where actual work was being done on the strip and where constant current was not being maintained purposely, showed that the torque required by the drive decreased more rapidly than the speed. This means that the armature current decreased more rapidly than the speed and in almost every case the armature current was such that an open or protected motor would operate safely at 10 per cent or even less of rated speed if it had been selected properly for the required load at rated speed.

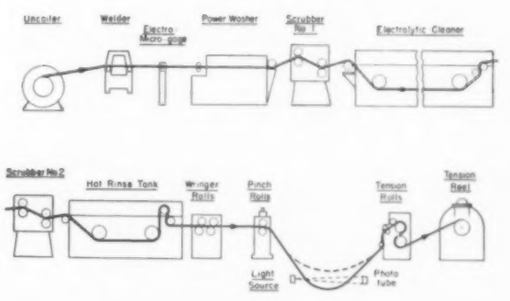
The foregoing is not applicable to the selection of motors for tension uncoilers, winding reels, and other drives where the current is maintained constant in order to maintain a uniform strip tension. In such cases the motors should be selected in accordance with the trend of the curves shown in Figure 10. For example, let us assume that we wish to select a reel motor to operate continuously at 10 per cent of rated speed and that our load will require 5 hp at this reduced speed. Reference to Figure 10 will indicate that for satisfactory operation our motor should then be rated $\frac{5}{0.6} \times 10$, or 84 hp at top speed. This is an extreme case and is used only to illustrate the point since it would probably be more economical to force ventilate a 50 hp motor than to apply an 84 hp motor.

Obviously, the above procedure can be tempered somewhat if the operation at reduced speed is only occasional or we are willing to permit a somewhat higher temperature rise. In any event, however, the greater the range of operating speed by voltage control, the more essential it is to take into account the operation at reduced speed when selecting the motor for constant current drives.

For all practical purposes, the generator is not affected by the operation at reduced speed, nor is it concerned with the fact that because of operation at reduced speed it is sometimes necessary to apply a motor with a rating at top speed larger than actually required at the top speed of the drive. Furthermore, the actual current drawn by the motor will be at least equal to or higher at top speed than that at low speed and the greatest load on the generator therefore occurs at the high speed. As a result, the generator should be selected on the basis of the actual load at top speed and not on the basis of the motor rating at that speed since the motor rating may be fictitious. For instance, in the example just cited the generator need only deliver enough current to take care of the 50 hp necessary to drive the reel at top speed rather than the 84 hp which the motor must be capable of delivering.

Where a processing line includes drives which "pump-back" into the variable voltage system, such as the drag generators on the bridle rolls or on the tension uncoilers, the determination of the required generator capacity for this particular part of the line requires special consideration. We have previously said that under average conditions on a high speed cleaning line, the drag generator on the bridle roll should have a horsepower rating of approximately 80 per cent of the required reel motor horsepower, or a kilowatt rating of approximately 60 per cent of the required reel motor horsepower. On this basis, the losses in the system which consist of the friction loss of the reel drive, the friction loss of the bridle drive, and the electrical loss of the bridle drag generator amount to approximately 20 per cent of the reel motor horsepower, and this 20 per cent must be supplied by the main generator. In addition, the generator must supply the electrical and mechanical

Figure 12 — Schematic drawing of continuous cleaner line.



osses of the reel motor itself. If we assume that the reel motor has an average efficiency of 90 per cent, the generator must then supply power equal to approximately 30 per cent of the rating of the reel motor.

In the case of the pinch roll and the tension uncoiler, the generator must also supply the power necessary to pull the strip through the tanks. In any case, however, the power which the generator must provide is equal to the difference between the input to the pinch roll or reel and the output of the associated drag generator plus the electrical and mechanical losses of the pinch roll or reel motor, whichever the case may be.

At this point, it will be interesting to select motors and motor-generator sets for several common types of processing lines on the basis of the data which has been presented. We will start with a tinplate side trimming and shearing line consisting of a motor driven uncoiler, side trimmer, and leveler-shear as shown in Figure 11. As a basis for the selection of the motors and motor-generator sets, let us assume that the line is to side trim and cut to length open hearth, annealed and temper rolled tinplate strip No. 26 to 36 gauge, 18 to 36 in. wide with an operating speed of 250/750 rpm by means of adjustable-voltage control.

Our investigation has shown that a 3 hp motor will be adequate to take care of the friction or normal running load of the uncoiler; however, the accelerating duty will probably require a motor with a normal rating of at least 7½ hp. If we know the total WR^2 of reel and coil, we can make calculations to determine the suitability of a 7½ hp motor.

Let us assume the following data:

Coil and reel WR^2	30,000
Motor WR^2	30
Motor rating	7½ hp — 450/1800 rpm
Gear ratio	13.33/1
Then:	
Total WR^2 (referred to motor shaft)	168
Normal motor torque	88 lb-ft
Friction torque (based on 3 hp at 450 rpm)	35 lb-ft
Permissible motor torque during acceleration (150 per cent normal)	132 lb-ft
Accelerating torque (permissible torque — friction torque)	97 lb

$$\text{Accelerating rate (rpm per sec)} = \frac{\text{Accelerating torque} \times 308}{WR^2} = 177$$

On this basis it would require approximately 2.5 seconds to accelerate the uncoiler to 450 rpm and this should be more adequate even with allowance for the fact that the accelerating torque will probably average less than the permissible value.

Since the side trimmer and leveler-shear do actual work on the strip, and as previously explained the motor current decreases more rapidly than the speed, we need not concern ourselves with the speed range over which these drives must operate, but can select the motors on the basis of the required power at 750 fpm.

Reference to Figure 3 shows that approximately 1.7 net hp is required to side trim .012 in. thick tinplate at 750 fpm. Use of the following formula:

$$\text{Net hp} = 1.7\left(\frac{.01875}{.012}\right)^{1.5}$$

indicates that approximately 3.5 net hp will be required to side trim .01875 in. (No. 26 gauge) tinplate at 750 fpm. If we assume that the friction of our side trimmer is comparable to that shown in Figure 3, the side trimmer motor must then be capable of delivering 7.5 hp at 750 fpm.

The data available for the leveler-shear is not as complete as that for the side trimmer, but reference to Figure 5 will show that slightly over 55 hp will probably be required at 750 fpm for the particular type of leveler-shear which is shown.

We then have 7½ hp required for the uncoiler, 7.5 hp for the side trimmer, and 55 hp for the leveler-shear. This is a total of 70 hp and under ordinary conditions will require a 60 kw motor-generator set.

Next, we can select motors, drag generators and a motor-generator set for an electrolytic cleaning line for tinplate strip such as shown schematically in Figure 12. The tinplate will have a maximum thickness of .012 in., a maximum width of 36 in. and the maximum line speed speed will be 2000 fpm. On the assumption that the line will never operate continuously below 1000 fpm, we may decide to make no allowance for operation at reduced speed since our motors should remain within safe temperature limits at 50 per cent of rated speed.

With the foregoing as a basis, reference to Figure 7 will show that two drag generators, each rated 8½ kw, will be satisfactory for maintaining 1000 psi back tension. Figure 8 will show that just slightly over 100 hp will be required for the pinch roll with the uncoiler producing 1000 psi back tension and an average drag through the cleaning tanks and brushes of 30 lb per inch of strip width.

On the basis of Figure 9, the reel motor will have to develop 115 hp to give a winding tension of 4000 psi and the bridle roll drag generator will have to be rated 92 hp or 70 kw.

We then have two 8½ kw drag generators on the uncoiler, a 100 hp motor on the pinch roll, a 70 kw drag generator on the bridle stand and a 115 hp motor on the tension reel. If we assume the reel and pinch roll motors to be 90 per cent efficient, the motor-generator set will then have to supply a net load of 122 hp and approximately 100 kw will be required.

Conclusion

The tests, data, and conclusions set forth in this paper should be regarded as a pioneering effort and not as the final word or a complete study of any of the subjects involved, especially since each subject would warrant a complete study in itself. There is quite often a wide difference of opinion regarding the correct sizes and types of motors and motor-generator sets to be applied to specific applications and it is hoped that further tests can be made to substantiate or modify, as the case may be, the conclusions in this paper and that similar studies can be made for other types of individual and coordinated drives.

DISCUSSION

PRESENTED BY

R. A. GEUDER, Manager, Metal Industrial Applications, Reliance Electric and Engineering Company, Cleveland, Ohio

H. W. POOLE, Steel Mill Section, Industrial Engineering Department, General Electric Company, Schenectady, New York

R. H. ELLIS, Electrical Engineer, United Engineering and Foundry Company, Pittsburgh, Pennsylvania

J. R. ERBE, Industry Engineering Department, Metal Working Section, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

R. A. GEUDER: I believe this is the start of a fine job. If we can get some more of these papers it may help all of us to reach an agreement on motor application and I think the industry will be better served.

One thing occurred to me as the paper was being presented. I know Mr. Poole did not mean to get into any specific case, but I am thinking of one application on a process on which he touched only slightly. That is on the combination of the slitter and tension reel motor, wherein the tension reel or re-wind pulls against the slitter motor. It is not only the selection of the motor-generator set that must be considered, but we have also the selection of the slitter motor, which under normal conditions, doesn't deliver any appreciable horsepower, but which, when the line is first started and the strip is first inched through the slitter, must deliver sufficient power to actually slit the strip.

In fact, we have found that on lines of this kind, when they are in operation that the operators seem to get the best results when the load on the slitter motor is merely the frictional load and where the major portion of the slitting itself is done by the tension in the strip. Therefore, we must not only consider what the normal running load of that slitter motor is, but also the job of starting off the line and make our selection accordingly.

Mr. Poole, in his brief presentation, indicated the selection of motor-generator sets. I want to merely emphasize the fact that as we get into these coordinated drives we are using variable-voltage control more and more. It is interesting to note that this voltage control has also been carried quite successfully into wire blocks having multiple motors, and I think by the time of the next convention we will have some operating data on this subject.

R. H. ELLIS: Will Mr. Poole explain to us just when he decides to use the motor generators? Is it a question of the number of units or some other consideration?

J. R. ERBE: I think Mr. Poole should be complimented on the amount of test data that he has compiled on this subject. I think it will certainly be an addition in the advancement of the art. There is one thing I would like to mention, and that is that as we increase the speed range of these lines, we need to give more and more consideration to the characteristics of the motor itself, in addition to its horsepower requirements.

H. W. POOLE: Mr. Ellis brought up an interesting question when he asked at what point it becomes desirable to use a variable-voltage motor-generator set for processing line operation.

My off-hand answer would be that variable-voltage control should be used everywhere; however, there are some very definite reasons for the selection of this type of control and some of the most important are as follows:

1. Many processing lines require a strip speed range of 3 to 1 or greater and in addition require 3 to 1 or 4 to 1 speed range for coil build-up on the reel or uncoiler. In such a case, the reel or uncoiler motor would have to have a total speed range of 9 to 1 or 12 to 1 and since this is beyond the range of good engineering practice, it becomes advisable to use variable-voltage control for the strip speed of 3 to 1 and motor field control for the reel diameter change of 3 to 1 or 4 to 1.

2. There are numerous instances where the accelerating peaks caused by magnetic control are injurious to the mechanical equipment and this can be corrected by using smoother, simpler variable-voltage control.

3. Whenever the speeds of more than two motors are to be synchronized during acceleration and deceleration as well as when running at steady speed, a satisfactory job can very seldom be done with anything except variable-voltage control.

Mr. Geuder called attention to the specific case of a slitter motor which must have sufficient torque to actually slit the material during the threading operation, but which needs to supply only enough torque to overcome friction during the running cycle. It is quite true that this case, as well as many others which could be brought up, requires special treatment, and here as in every other instance the selection should be tempered with a little common sense in order to arrive at the best solution.

BACKING-UP ROLLS . . .

. . . . in discussing the manufacture of back-up rolls, the author advances a method for calculating roll life, taking into consideration the footage of material rolled. .

By J. A. Succop

HEPPENSTALL COMPANY

PITTSBURGH, PENNSYLVANIA

**Presented before A. I. S. E.
CLEVELAND DISTRICT SECTION
June 1, 1942**

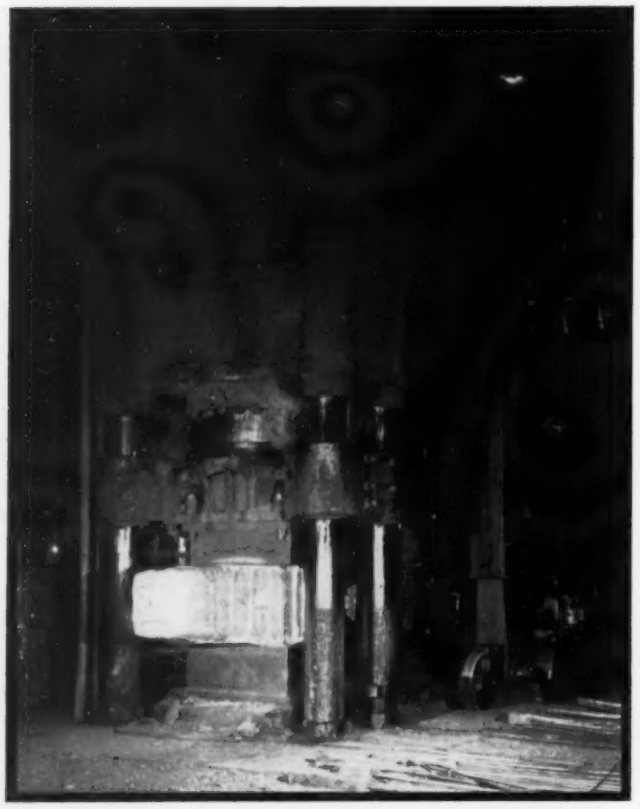


Figure 1 — Press forging of ingot, the first step in the manufacture of forged roll sleeves.

▲ THE subject of backing-up rolls in all its phases is entirely too large to discuss in a brief presentation. To thoroughly understand the application of roll sleeves or solid backing-up rolls, one has to live with them in service, and even then it is a common experience to find that even the strip mill superintendents do not know all the answers. At the writer's company we have made a study of the manufacture of both sleeves and arbors for the production of composite backing-up rolls, as well as the re-capping of worn-out solid rolls, but our knowledge of mill service is extremely limited. It appears that each mill is an individual unit in itself and only in a very general way, can the conditions of one mill be compared with a second mill, even though the two mills might be rolling the same type and size of material.

A roll sleeve, while in service, is subjected to many variable stresses, some in the form of static pressure and some in the form of impact. Forged steel, for reasons which are well known, possesses greater density and greater homogeniety than the average casting and this quality in the forged sleeve is one of the reasons for expecting greater life than the expected life of a solid cast roll, or a cast roll sleeve. The second reason, which is of great importance, is the comparative ease and safety with which a sleeve may be hardened and tempered, as compared with the manufacture and hardening of a solid roll, due to mass involved.

Quality is of paramount importance in the manufacture of roll sleeves. Care must be exercised in the selection of raw material for the open hearth, the proper size ingot must be used to give the desired forging re-

Figure 2 — The blank is next forged in the upset press.

duction in all directions, as directional properties are of vital importance in the life of a sleeve.

Since relatively large ingots of the highest quality are required to be used for sleeves, electric or acid open hearth steel is recommended. The ability of the manufacturer of a sleeve depends upon the experience and fabrication facilities of his plant. Several methods of forging sleeves are employed. However, the most popular method used is to cog the ingot into a billet and then cut off the required weight, upset forge, hot punch and mandrel forge. After forging, cooling at a predetermined rate must follow in order to avoid flakes and internal fractures.

After forging the sleeve on a mandrel, which permits thorough reduction and grain refinement throughout the entire cross-section of the forging, the sleeve is given a high normalizing treatment, followed by an annealing treatment. After rough turning, the sleeve is hardened and tempered to the required hardness. The superiority of this type of treatment for backing-up roll sleeves is due to the hardness which may be obtained, as well as the fact that hard cementite particles are distributed uniformly throughout the steel and contribute to better wear resistance.

The selection of the proper hardness of a roll sleeve is very important. High hardness minimizes spalling, but materially increases failure by splitting. Too soft a sleeve will promote spalling and also develops an "out of round" condition and loosens on the mandrel. Therefore, it is very important to select the proper hardness and this proper selection will vary according to the mill, analysis of the steel and the type of heat treatment selected for the hardening operation. The hardness generally falls between 55 and 65 scleroscope for the average. Hot mill backing-up roll sleeves are made to the low side of hardness and cold mill sleeves to the high side because the cold mill pressures are higher than that of the hot mill.

Arbors are either turned down from solid rolls, or made from forgings. If made from forgings, they are usually of a mild alloy steel, air hardened and tempered to secure a combination of hardness and toughness desired to withstand the extremely high pressure developed in a mill. After final heat treatment, the arbors are machined and the body ground to a pre-determined size for the shrinking of the sleeve. The hardness of a forged and heat treated arbor will vary according to size, but generally speaking, the average is between 35 and 45 Shore hardness. The major portion of the arbors used are made from worn-out or badly spalled cast steel solid rolls. These cast steel arbors are apparently entirely satisfactory as some arbors are re-sleeved three and four times before being scrapped.

A careful inspection of the cast arbor is made before using by testing each arbor for soundness by the sonority test. This consists of setting the arbor or the solid sleeve on knife edges and striking with a hammer to study the vibration sounds. This test is effective inasmuch as a number of cast arbors have been rejected for use and later by breaking the arbor with a drop ball a large internal or deep neck crack has been uncovered.

In selecting the dimensions of the outside diameter of an arbor and the inside diameter of a sleeve, careful consideration must be given to the degree of shrinkage. Various plants differ as to the amount of shrinkage allowance. It might be stated that the degree of shrink-

Figure 3 — View showing blank being removed from heating furnace for final forging operation.

TABLE I

	Gauge, in.	Ratio of elongation	Per cent of reduction
Band entering No. 1 stand is	.0800	1.28	21.8
Band leaving No. 1 stand is	.0625		
Band entering No. 2 stand is	.0625	1.8657	46.3
Band leaving No. 2 stand is	.0335		
Band entering No. 3 stand is	.0335	1.8715	46.5
Band leaving No. 3 stand is	.0179		
Band entering No. 4 stand is	.0179	1.4553	31.3
Band leaving No. 4 stand is	.0123		
Band entering No. 5 stand is	.0123	1.4302	30.2
Band leaving No. 5 stand is	.0086		

age is a function of chemical composition, method of manufacture and hardness of the sleeve on the inside and outside diameters. The amount of shrinkage becomes a critical function in the case of high hardness sleeves. Whenever the shrinkage allowance is too great, failure, due to splitting, will result, while on the other hand, slippage will occur whenever the allowance is too small.

Sleeves are now designed with a shoulder on the arbor and a recess on the inside diameter of the sleeve. A lock ring is also inserted either at the shoulder end or the opposite end of the sleeve. This device will prevent the sleeve from moving lateraly, but the shrinkage is all that prevents the sleeve from moving circumferentially.

It is advisable, particularly in the case of long sleeves, to permit cooling during shrinkage of the central portion before cooling the ends. If the reverse process occurs, improper bearing at the center will result and the inherent stresses, in addition to the working stresses, might cause cracking of the sleeve.

Little can be said, due to the practical limits of this paper, about the service of forged backing-up roll sleeves because of the many variables existing in each rolling mill. It appears that each mill is an individual problem and what is true about the service and requirements of one mill, is not necessarily true of the same type of a mill, rolling the same grade and size of material. Since there are many types of mills which employ the use of backing-up rolls, the variable problems are given further complications.

There are many factors which affect the life and service of roll sleeves. Some are natural abuse and beyond the control of the operator, others are due to the normal expectancies and still other abuses are the result of today's efforts to increase production. Some of these factors can be controlled and are caused by carelessness and negligence on the part of the operator.

The first factors are well known by all operators and need not be discussed. The neglect of the controllable factors are the usual cause of the short life of sleeves, and with careful operation and special attention given

TABLE II

	No. 1 stand	No. 2 stand	No. 3 stand	No. 4 stand	No. 5 stand	Total
No. 1 roll						
Actual tons	0	42,408	31,855	79,376	38,586	192,225
Foot-tons	0	79,120	111,226	403,333	280,421	874,100
No. 2 roll						
Actual tons	67,408	39,615	55,029	29,736	0	191,788
Foot-tons	67,408	73,908	192,440	151,098	0	484,554
No. 3 roll						
Actual tons	4,131	5,658	26,812	40,472	82,206	159,279
Foot-tons	4,131	10,556	93,617	205,650	597,427	911,381

to the care of sleeves, increased service life can be expected.

At the extreme high pressure developed in the mills, all sleeves are subject to cold working of the surface metal. In due course of time, this metal will fatigue and develop small cracks. If the cracks are permitted to grow, large spalls are certain to result. However, if these cracks are removed by frequent light cuts, in the lathe, the life of the sleeve can be materially improved. It is generally accepted that cracks cannot be ground out, but will increase in depth and remain in the roll after the grinding operation.

The selection of the proper time to machine turn a roll or roll sleeve before grinding is a matter of judgment of the roll superintendent. Some mills turn a roll sleeve after every installation, some after two or three installations, while others measure the hardness on the roll surface and when an increase of three to four points of scleroscope hardness is obtained, the strained surface is machined instead of ground. Still other shops turn only if more economical to turn them to grind out spalls. If these highly strained areas are not frequently removed, additional pressure on the surface of the sleeve further fatigues the metal and concentrates the stresses at the base of the minute cracks and spalls are certain to develop.

The service of a roll or sleeve is generally referred to as so much tonnage rolled and no reference made as to which stand the backing-up roll had spent most of its existence. This company has advocated for years that the service of strip mill rolls and sleeves should be discussed in relation to footage or mileage actually going through the rolls, rather than tonnage. This idea was discussed with a number of strip mill superintendents and through the thoughtful efforts of William E. Lloyd of the Youngstown Sheet and Tube Company, Indiana Harbor, Indiana, the writer would like to present for your consideration, a set of factors, which, when applied to the service of a roll or roll sleeve, will give a truer picture of the life of a roll than can be judged by merely stating the tonnage rolled. Mr. Lloyd wishes to

Figure 4 — The forged sleeve is given a heat treatment both before and after rough turning.

Figure 5 — Machine turning of the bore of the forged, annealed sleeve.

be clearly understood that these factors are entirely his own opinion and do not necessarily represent the ideas or policy of his company; also that he uses these figures merely as a guide for final judgment of his roll life.

The true service life of a roll or roll sleeve cannot be determined by the actual tonnage produced, for the stand of the mill in which the roll was used must be taken into consideration. The only equitable method of comparing the service received would seem to be to establish a factor to be used in converting the tonnage rolled in each stand to terms of some one stand of the mill. This should be done on the basis of relative footage of roll circumference per ton of steel produced. For the want of a more accurate term, we shall call this figure "foot-tons." This comparison is not entirely correct since the thickness of the piece in each stand is not considered, nor is the variable percentage of reduction in each stand compensated. The comparison, however, will be much more nearly a measure of merit than the bare statement of final tonnage.

In order to establish one set of factors, let us take a typical series of mill reductions in a five stand tandem mill reducing a band .0800 in. thick to tin plate .0086 in. thick. All back-up and work rolls will be assumed to be at new diameters. The speed ratio of stand to stand, therefore, will be the same as the elongation of the piece since an equal volume of steel per unit of time must be delivered from each stand. A typical schedule of roll settings is as follows:

No. 1 stand	.0625 in.
No. 2 stand	.0336 in.
No. 3 stand	.0179 in.
No. 4 stand	.0123 in.
No. 5 stand	.0086 in.

The ratio of elongation and per cent of reduction of the strip is determined as shown in Table I.

The elongation of the strip in each stand for the

settings shown above would be:

No. 1 stand equals	1.2800
No. 2 stand equals	1.8657
No. 3 stand equals	1.8715
No. 4 stand equals	1.4553
No. 5 stand equals	1.4302

The speed ratio is equal to the elongation, and, therefore, the computed figures are the same.

Use the factor 1 as the speed of No. 1 stand; the speeds of the other stands would be as follows:

No. 1 stand — 1	1.0
No. 2 stand — 1×1.8657	1.8657
No. 3 stand — 1×1.8657×1.8715	3.4916
No. 4 stand — 1×1.8657×1.8715×1.4553	5.0813
No. 5 stand — 1×1.8657×1.8715×1.4553 ×1.4302	7.2675

As stated heretofore, the volume or weight of steel produced per unit of time from each stand must be the same. Therefore, it is apparent from the above calculation that the same point on the circumference of a backing-up roll in No. 5 stand will be under compression 7.2675 times as often as a point on the circumference of a roll in No. 1 stand, while rolling a ton of steel.

Our factors, therefore, for computing the foot-tons on a backing-up roll will be the same as the relative speeds of each stand.

No. 1 stand	1.000
No. 2 stand	1.8657
No. 3 stand	3.4916
No. 4 stand	5.0813
No. 5 stand	7.2675

Examples of the application of the factors determined as illustrated are as follows:

Three sleeves in service in the same mill showed, according to the mill records, tons rolled, as well as comparison of foot-tons as in Table II. It can be readily seen by comparing the service life of these sleeves why it is necessary to report the service life of rolls and sleeves by some other factor than just tons rolled.

A study of the comparative results of No. 1 and No. 2 rolls shows that the actual tons rolled is almost identical. Transposing the actual tons rolled in each stand into "foot-tons," you will note that No. 1 roll was almost twice as satisfactory as No. 2 roll. The same comparison is true of No. 3 roll. This roll with less total tonnage rolled than either No. 1 or No. 2 roll, produced greater foot-tons. This is true because of the length of service the roll had in No. 5 stand.

This method of computing the service life of backing-up rolls and roll sleeves and which was briefly given to you for your further consideration and comments, is possibly only one of many ways in which the life of a roll can be properly judged. So, regardless of what method is used, let us adopt some better means of judging and reporting roll life and sleeve life than just total tonnage which passes through the mill.

The original subject of this discussion was to have been "Backing-up Roll Sleeves" and because of the similarity of conditions of a solid roll and a composite roll, no distinction was mentioned. The average life of the two types of rolls is, however, entirely different. The density of the forged steel and the ease with which the forging can be grain refined during heat treatment, all contribute to a material increase in life of the forged sleeve type roll compared with a solid cast roll.

A study of this comparison was made at a certain strip mill. The mill was a five stand tandem cold mill, rolling mostly tinplate strip. This study was made on 23 solid and composite backing-up rolls. The average tonnage obtained from the solid cast rolls was 136,616

Figure 6 — The forged sleeve is next shrunk on the arbor.

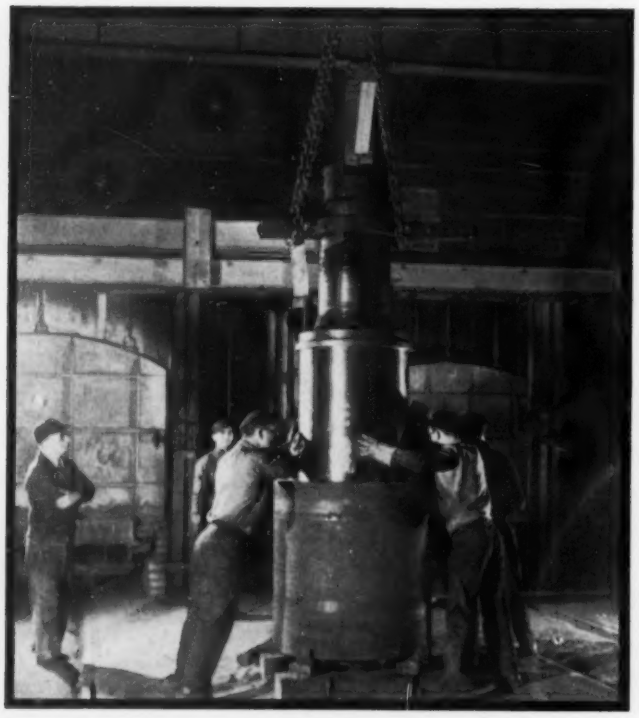
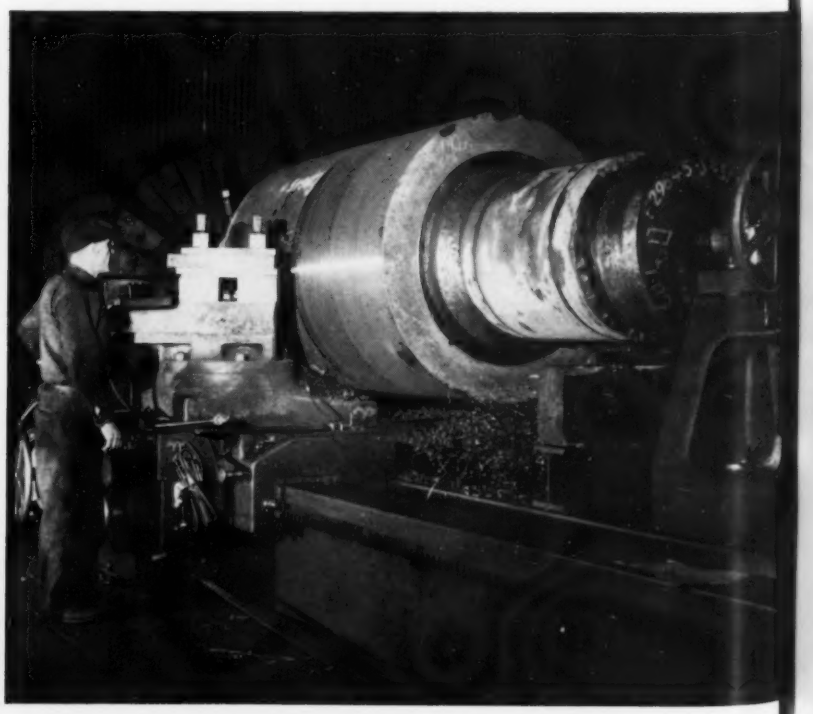


Figure 7 — The final composite roll is then turned in a lathe.



net tons. These rolls were furnished by four leading cast roll manufacturers and the average of each company was very much the same. The average of the forged roll sleeves used on the same mill was 217,880 net tons. This figure is approximately sixty per cent increase in service life. These values are based entirely on net tons rolled.

If the comparison had been made on foot-tons rolled, as explained earlier in this paper, the values would have been as follows: Average foot-tons for solid cast rolls 471,639, whereas the average foot-tons for the sleeves was 960,489. These figures show an average increase of over 100 per cent.

These figures are not individual to this one mill, but are true in practically all four-high strip mills, either hot or cold rolling, both in this country, as well as abroad.

The replacement of solid cast rolls with composite forged sleeves is beyond any experimental work. Over 500 sleeves have been installed in service in practically every hot and cold mill in this country, and with a few exceptions, have more than doubled the tonnage obtained on solid cast steel rolls.

In closing this brief paper on backing-up rolls and roll sleeves, the writer would like to further suggest that each man who has in the past based his judgment of the service of a roll sleeve or a solid roll, on the total net tons rolled, and gave no thought on the location of the roll in the mill, adopt for trial purpose, the proposed method of developing a factor for each stand and determine the foot-tons rolled. By so doing, a fairer comparison of the roll life can be made and a fairer judgment can be obtained.

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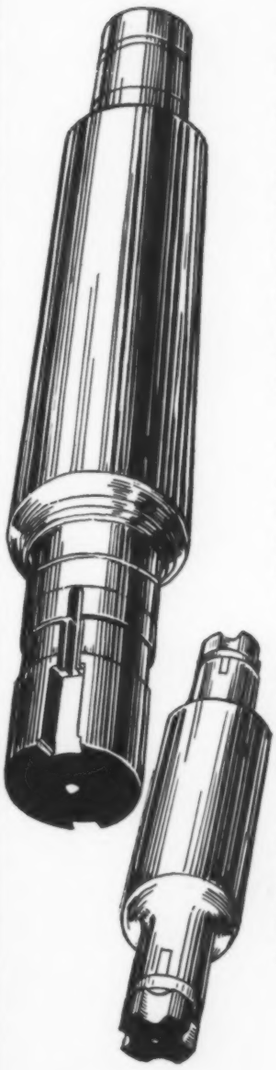
NATIONAL ROLLS



The Waste in Roll Abuse

THE finest rolls can be overworked, permitted to overheat, or bruised by hurried crane handling, but save in situations where production speed is imperative and roll-cost not a factor, such abuse is to be deplored.

Rolls, like men, grow "tired" from overwork and abuse; but after a cooling rest and perhaps resurfacing, return as strong as ever to continue the fight.

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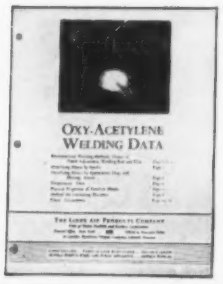

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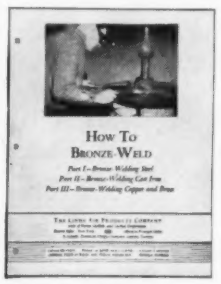
12 pages—Form 4600

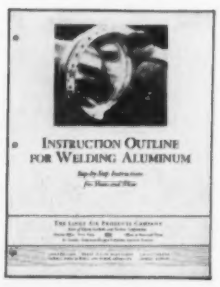
Charts, tables, and recommended welding methods; choice of flame adjustments, welding rod, and flux; methods for identifying metals; physical properties of familiar metals; temperature data chart; and a conversion table for hardness numbers are included in this booklet.



HOW TO BRONZE-WELD

16 pages—Form 4328

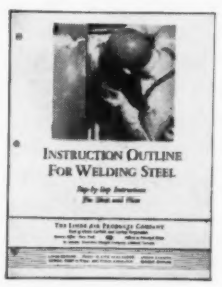
This booklet discusses the theory and advantages of bronze-welding, and describes by means of step-by-step pictures correct techniques for bronze-welding steel, cast iron, copper and brass. Bronze-welding and bronze-surfacing techniques are also shown in pictures of practical applications.



INSTRUCTION OUTLINE FOR WELDING ALUMINUM

8 pages—Form 4538

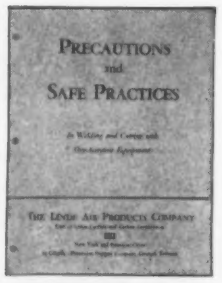
Instructions for welding aluminum sheet and plate, including the choice of proper flame and rod, the joint design, the use of jigs and supports, and cleaning and fluxing, are given in step-by-step illustrations. How the physical characteristics of aluminum affect welding technique is also discussed.



INSTRUCTION OUTLINE FOR WELDING STEEL

20 pages—Form 4645

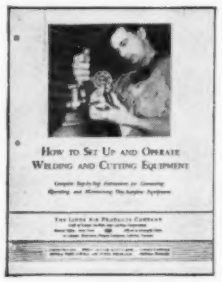
This is a series of practice exercises ranging from primary melting to making position butt welds in steel sheet and plate. Instructions for blowpipe manipulation and rod deposit, and examples of both good and poor welds, are included for guidance in correcting faulty procedure.



PRECAUTIONS AND SAFE PRACTICES

56 pages—Form 2035

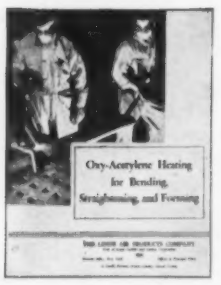
A copy of this booklet should be in the hands of every operator of oxy-acetylene welding and cutting equipment. It completely covers all the safety precautions that should be observed in setting up and operating equipment, in handling calcium carbide and oxygen and acetylene cylinders, and in maintaining equipment.



HOW TO SET UP AND OPERATE WELDING AND CUTTING EQUIPMENT

20 pages—Form 5165

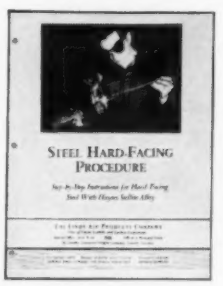
Complete, step-by-step illustrated instructions for connecting, operating, and maintaining oxy-acetylene welding and cutting equipment. A careful study of the various suggestions in this booklet will aid all operators in getting the most out of their equipment, and will help to promote safety.



OXY-ACETYLENE HEATING FOR BENDING, STRAIGHTENING, AND FORMING

8 pages—Form 4200

The many applications of the oxy-acetylene flame for "smithing" operations, its use in automotive production and repair, in the boiler shop, and for upsetting and stretching, are reviewed. Three methods for straightening bent shafts are given.



STEEL HARD-FACING PROCEDURE

8 pages—Form 3491

The special instructions given here, based on the general hard-facing procedures, should prove helpful to everyone applying Haynes Stellite alloy to steel surfaces. A chart of hard-facing materials data and a listing of suggested hard-facing applications are also included.

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OBSERVE FIRE PREVENTION WEEK, OCTOBER 4 - 10

PROGRAM

ANNUAL MEETING & ENGINEERING CONFERENCE

ASSOCIATION OF IRON & STEEL ENGINEERS

WILLIAM PENN HOTEL · PITTSBURGH · PA

SEPTEMBER 22 · 23 · 24

. . . In issuing this invitation to the engineering and operating personnel of the iron and steel industry to attend the annual meeting and engineering conference of the Association of Iron and Steel Engineers, I am giving the opportunity for the free exchange of ideas and information which industry has found so necessary in increasing production to meet the war program. I strongly urge everyone to take advantage of this opportunity to help the war effort by active participation in this meeting.

Thos. E. Vaughen

PRESIDENT

PRESIDING OFFICERS *and* A

H. H. LOWRY

F. K. FISCHER

J. H. MILLER

C. J. WYROUGH

HOWAR

P. J. DOYLE

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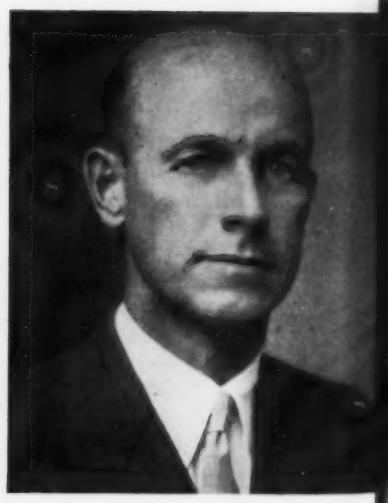

E. GORDON FOX

A. D

F. C. FRYE

ALEX MONTGOMERY, JR.

E. L. HEMINGWAY

J. K. HODNETTE

N. A.

AUTHORS at CONVENTION

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J. D. CAMPBELL

R. J. GREENLY

A. E. GIBSON

A. D. BRODIE

J. H. HOPPER

C. A. BRASHARES

M. D. HARBAUGH

N. A. MALONE

A. J. FISHER

J. L. MILLER

W. W. COOPER

Tuesday, September 22

9:00 A.M. — REGISTRATION.

Chairman
CHARLES H. WILLIAMS
Assistant to Vice President of Engineering
United States Steel Corporation of Delaware
Pittsburgh, Pennsylvania

Vice-Chairman:
HOWARD F. MARTIN
Maintenance Superintendent
Jones & Laughlin Steel Corporation
Aliquippa, Pennsylvania

9:15 A.M. — BUSINESS SESSION — Cardinal Room.

Chairman:
T. E. HUGHES
Superintendent of Maintenance
Carnegie-Illinois Steel Corporation
Duquesne, Pennsylvania

Vice-Chairman:
J. L. MILLER
Assistant Combustion Engineer
Republic Steel Corporation
Cleveland, Ohio

9:30 A.M. — ELECTRICAL ENGINEERING DIVISION — Cardinal Room.

Chairman:
L. V. BLACK
Superintendent of Electrical Department
Bethlehem Steel Company
Bethlehem, Pennsylvania

Vice-Chairman:
J. H. MILLER
Electrical Engineer
Wisconsin Steel Works
Chicago, Illinois

"Air-Break Circuit Breakers for Industrial Use," by Ralph Lockett, Application Engineer, I-T-E Circuit Breaker Company, Philadelphia, Pennsylvania.

"Carbon Brushes — Selection, Application and Maintenance," by Richard Rowell, Assistant Electrical Superintendent, Wheeling Steel Corporation, Steubenville, Ohio.

"Electrical Equipment for Continuous Electrolytic Tinplating of Steel Strip," by J. H. Hopper, Industrial Engineering Department, General Electric Company, Schenectady, New York.

12:00 — LUNCHEON — Urban Room.
Speaker: R. W. Wolcott, President, Lukens Steel Company, Chairman, American Industries Salvage Committee.

2:00 P.M. — ELECTRICAL ENGINEERING DIVISION — Cardinal Room.

Chairman:
H. R. FORD
Electrical Engineer
Wheeling Steel Corporation
Steubenville, Ohio

Vice-Chairman:
E. L. ANDERSON
Electrical Superintendent
Bethlehem Steel Company
Johnstown, Pennsylvania

"Conservation of Critical Materials in Transformer Design and Application," by J. K. Hodnette, Engineering Manager, Westinghouse Electric and Manufacturing Company, Sharon, Pennsylvania.

"Gauge Control in Cold Rolling of Steel Strip," by J. D. Campbell, Industrial Engineering Department, General Electric Company, Schenectady, New York.

"The Blast Furnace Skip Hoist," by Gordon Fox, Vice President, Freyn Engineering Company, Chicago, Illinois.

"Modern Blast Furnace Charging Equipment," by L. R. Milburn, Electrical Engineer, Great Lakes Steel Corporation, Ecorse, Michigan.

2:00 P.M. — WELDING DIVISION — Forum Room.

Chairman:
M. M. MacDONALD
Electrical Superintendent
Andrews Steel Company
Newport, Kentucky

Vice-Chairman:
WRAY DUDLEY
Assistant Superintendent of Maintenance
National Tube Company
McKeesport, Pennsylvania

"A-C Welding in the Steel Industry," by Emil Steinert, and W. W. Reddie, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

"Welding Metallurgy," by W. G. Theisinger, Director of Welding Research, Lukens Steel Company, Coatesville, Pennsylvania.

"Preparation and Handling for Welding," by A. E. Gibson, President, The Wellman Engineering Company, Cleveland, Ohio.

8:00 P.M. — "VICTORY THROUGH PRODUCTION" — Urban Room.
Motion Pictures, selected subjects.

Wednesday, September 23

9:00 A.M. — OPERATING PRACTICE DIVISION — Cardinal Room.

Chairman:
ALEX MONTGOMERY, JR.
Superintedent of Rolling
Carnegie-Illinois Steel Corporation
Duquesne, Pennsylvania

Vice-Chairman:
ALEX D. BRODIE
Superintendent 93 In. Cold Strip Mill and Galvanizing Department
Jones & Laughlin Steel Corporation
Pittsburgh, Pennsylvania

"Roll Oils and Coolants for the Cold Mill," by Maurice Reswick, Lubrication Engineer, Standard Oil Company of New Jersey, Pittsburgh, Pennsylvania.

"Electrolytic Tinning," by William Cooper, Electrical Engineer, Crown Cork and Seal Company, Baltimore, Maryland.

"Modern Roll Design Practice," by Clifford Elms, Chief Engineer, Pittsburgh Rolls Division, Blaw-Knox Company, Pittsburgh, Pennsylvania.

1:30 P.M. — OPERATING PRACTICE DIVISION — Forum Room.

Chairman:
WM. H. COLLISON
Superintendent of By-Product Coke Plant
Great Lakes Steel Corporation
Ecorse, Detroit, Michigan

Vice-Chairman:
J. D. JONES
Chief Engineer
Youngstown Sheet and Tube Company
Youngstown, Ohio

"Innovations in Coke Oven Design," by M. D. Curran, President, The Coal Carbonizing Company, St. Louis, Missouri.

"Properties of Blast Furnace Cokes: Their Measurements, Significance and Control," by H. H. Lowry and M. A. Mayers, Coal Research Laboratory, Carnegie Institute of Technology, Pittsburgh, Pennsylvania

"Coal Washing and Its Effect on Coke Oven and Blast Furnace Practice," by Wm. S. McAleer, McNally Pittsburg Manufacturing Corporation, Pittsburgh, Pennsylvania.

"Survey of the Iron Ore, Pig Iron and Scrap Situation," by M. D. Harbaugh, Vice-President, Lake Superior Iron Ore Association, Cleveland, Ohio.

1:30 P.M. — MECHANICAL DIVISION — Cardinal Room.

Chairman:
E. W. TREXLER
Superintendent Mechanical Department
Bethlehem Steel Company
Cambria Plant, Johnstown, Pennsylvania

Vice-Chairman:
C. J. DUBY
Chief Engineer — Warren District
Republic Steel Corporation
Warren, Ohio

"Application of Modern Cold Sawing Technique," by N. A. Malone, Plant Industrial Engineer, Steel and Tube Division, Timken Roller Bearing Company, Canton, Ohio.

"Development of Personnel in the Steel Industry," by Russell Greenly, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

"The Application of NE Steel," by John Mitchell, Metallurgical Engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

7:00 P.M. — INFORMAL STAG DINNER — Ball Room.

Speaker: J. S. Knowlson, War Production Board, Washington, D. C.

Thursday, September 24

9:00 A.M. — COMBUSTION DIVISION — Cardinal Room.

Chairman:
E. E. CALLINAN
Combustion and Refractory Engineer
Steel and Tube Division
Timken Roller Bearing Company
Canton, Ohio

Vice-Chairman:
C. J. WYROUGH
Superintendent Steam Efficiency and Combustion
Jones & Laughlin Steel Corporation
Pittsburgh, Pennsylvania

"Fundamentals of Open Hearth Design," by Fred Loftus, The Loftus Engineering Company, Pittsburgh, Pennsylvania.

"Relation of Flame Character to Open Hearth Operation," by A. J. Fisher, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland.

"Developments in Steel Plant Refractories," by C. A. Brashares, Technical Department, Harbison Walker Refractories Company, Pittsburgh, Pennsylvania.

1:30 P.M. — COMBUSTION DIVISION — Cardinal Room.

Chairman:
E. C. McDONALD
Combustion Engineer
Republic Steel Corporation
Corrigan-McKinney Works
Cleveland, Ohio

Vice-Chairman:
FRANK C. FRYE
Steam and Fuel Engineer
Great Lakes Steel Corporation
Ecorse, Detroit, Michigan

"Determination of Blast Furnace Gas Credits," by Frank E. Leahy, Superintendent of Fuel Department, Youngstown Sheet and Tube Company, Youngstown, Ohio.

"Modern Turbine Types and Design," by F. K. Fischer Central Station Steam Engineer, Westinghouse Electric and Manufacturing Company, Philadelphia, Pennsylvania.

Round Table Discussion — Steel plant fuel supplies.

1:30 P.M. — LUBRICATION DIVISION — Forum Room.

Chairman:
C. R. HAND
Lubrication Engineer
Bethlehem Steel Company
Sparrows Point, Maryland

Vice-Chairman:
P. J. DOYLE
Lubrication Engineer
Republic Steel Corporation
Cleveland, Ohio

"The Use of Addition Agents in Petroleum Products," by F. F. Musgrave, Assistant to Director of Research, The Lubri-Zol Corporation, Cleveland, Ohio.

"Bearing Surfaces," by E. L. Hemingway, Chief Metallurgist, International Machine Tool Corporation, Elkhart, Indiana.

"Turbine Lubrication," by Stanley O'Dette, Senior Field Engineer, Standard Oil Company of New Jersey, New York, New York.

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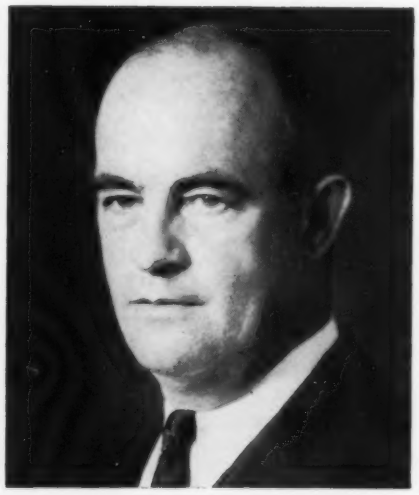

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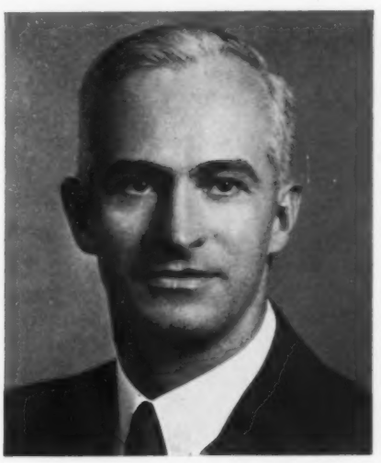

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...a real contribution to vital war production...*

UNITED STATES STEEL CORPORATION
OF DELAWARE

436 SEVENTH AVE.
PITTSBURGH, PA. August 12th, 1942.

B F FAIRLESS
PRESIDENT

Association of Iron and Steel Engineers
Empire Building
Pittsburgh, Pennsylvania

Gentlemen:

I am happy to join with the subsidiary companies of the United States Steel Corporation in extending to you a hearty welcome to Pittsburgh on the occasion of your annual meeting here from September 22-24 inclusive.

I am interested to note that in view of present conditions you have elected to forego the usual exhibits and other activities which ordinarily attend your convention, and that you will concentrate on the more serious aspects of an engineering conference.

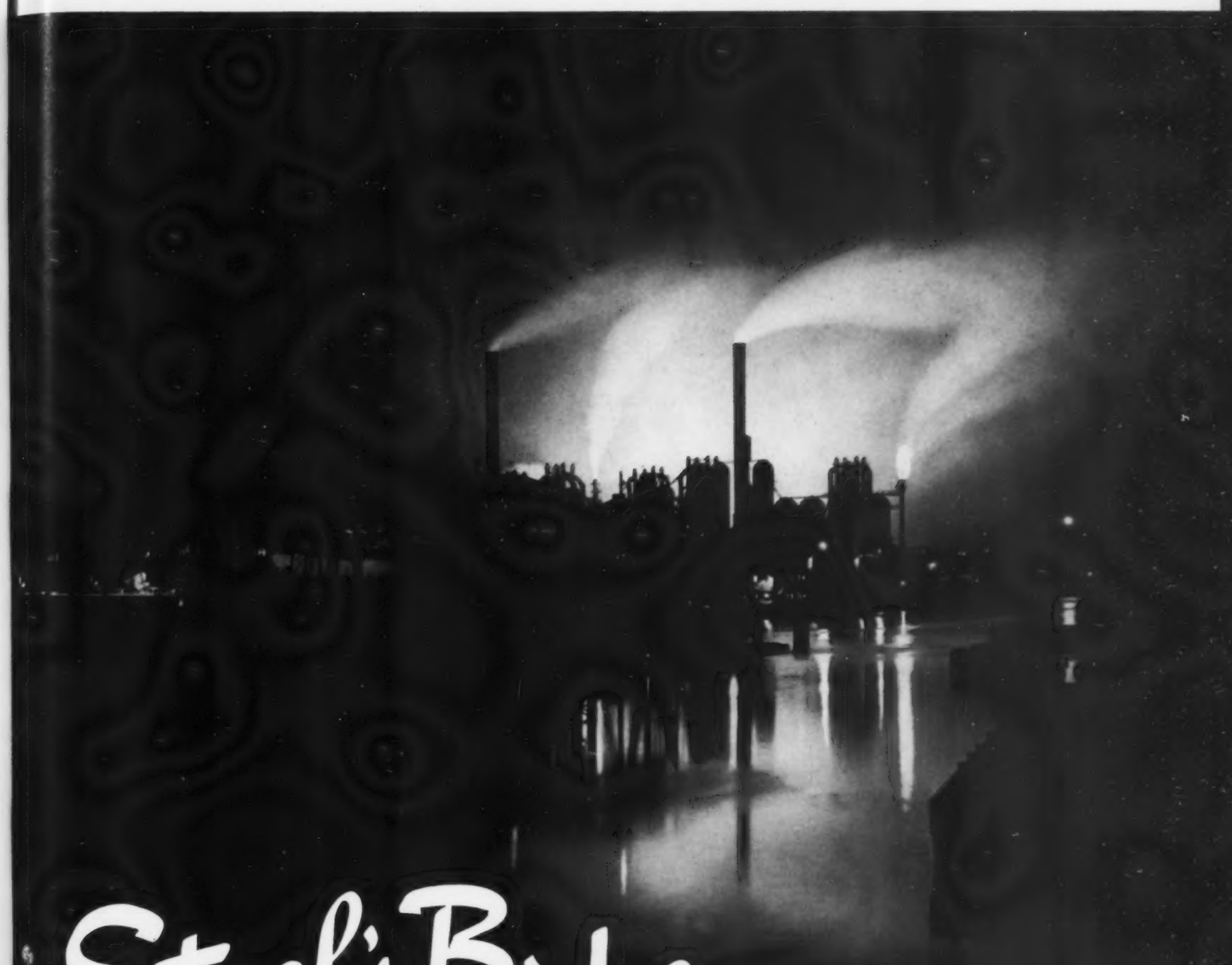
* The exchange of ideas, which attends the type of conference you plan, is a real contribution to vital war production, and I know will go far toward bringing about victory through production, to which all units in our industry are pledged in these grave times.

We welcome you to Pittsburgh and wish for your organization a successful meeting which will result in greater achievements for our industry in its service to our country.

Sincerely yours,

B F Fairless

President.



Steel's Bid for Victory

By T. J. Ess

THE answer to the steelman's prayer for greater production seems simple enough if one is content to accept the suggestion of one steel maker that all that is necessary is "To melt down the scrap faster, add the iron sooner, bring the lime up quicker, and tap heats more often." As desirable as this procedure sounds, it does not go far enough — no instructions are included as to what to do in the absence of scrap and iron. Hence, we must look farther afield for our answer, and the farther we go, the more Job's trials, by comparison, take on the aspect of a Roman holiday. Record quantities of steel from third-rate scrap, more high quality steel with dwindling alloys, fixed prices with ascending

STEEL'S BID FOR VICTORY

wages, sky-rocketing taxes, new regulations, mounting restrictions, a labor situation that certainly does not aid operating efficiency — these are but a few of the plagues that torment the industry today.

For years past, under a free competitive industrial system, American industry — enterprising, aggressive — has laid firm foundations for a healthy growth and an ultimate strength, which are only too welcome at the present time, and which, combined with the strenuous production efforts put forth by industry, can lead only to final victory in the present conflict. Up to the end of 1941, production was principally for civilian requirements, with national defense and armament for export a relatively small item. Since that time, however, the rapid shift of events has brought the problem of meeting a war program without precedent. It was necessary that industry convert from peace-time production to production for war — and industry has converted.

. . . critics of dubious qualification . . . "inefficiency and greed" . . .

What is true of industry in general applies to the iron and steel industry in no less degree. Subjected to the carpings of critics of dubious qualifications, accused of "inefficiency and greed," indicted for wilfully delaying vital programs, and the target of numerous barrages of verbal animosity, the steel industry's reply has been a prompt shift in the nature of its products, adjustments in processes to meet the new requirements, and a succession of new production records which would have formerly been termed impossible, if not actually fantastic. By reducing time for building, rebuilding and repairing producing units, by improved designs leading to longer life, by ingenious application of new ideas, and by the pooling and interchange of these ideas, the industry has materially increased the production capacity of existing equipment.

The shift in the nature of products, with curtailed sheet manufacture and increased plate, structural and rail production, has resulted in some dislocation of the flow of steel through the rolling and finishing departments. Thus, we hear of cases of certain mill departments or small non-integrated plants (usually sheet mills) being closed down, or operating only part time. Such news is often construed to mean that the industry is not operating at top speed, and brings out charges of conspiracy and intrigue from those who think you can pluck flowers from a blooming mill. The recent senatorial investigation of the steel situation, with all the finesse of a panzer unit, offered much testimony of like truck.

We have also heard much about steel shortages retarding war production. This is not so much a case of shortage as it is of unbalanced distribution. Each agency, playing the game of devil-take-the-hindmost, has scheduled requirements in excess of actual need, with the result that allocations for the third quarter covered only about 85 per cent of the requested amounts in certain classes of products. After further study, the schedule of requirements was revised downwards in accordance with ability to fabricate, ship, etc. Considerable thought has been given to the distribution of steel to the fabricators, and needful improvement is in the offing. The quota plan for production seems to be aiding operating efficiency in the steel plants. Exact figures on actual consumption and actual fabricating schedules would be a further boon.

How well the industry is situated to meet the demands placed upon it is indicated by the fact that, stupendous as seems the President's program for ships,

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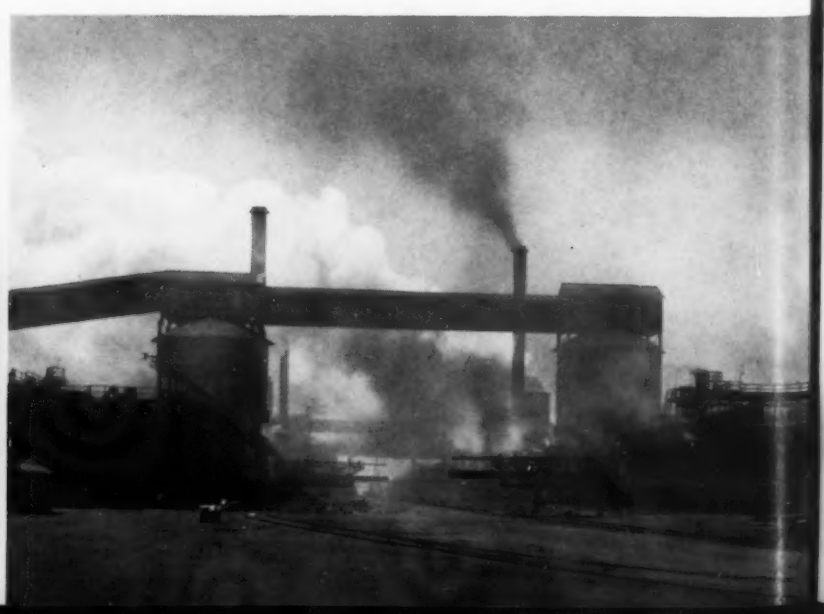


tanks and planes, steel-making capacity is adequate to supply the war program — perhaps more than adequate to supply the available means for fabricating such material. That civilian consumption must be vigorously held down in order to supply the war needs is certainly not of drastic consequence — it was low in 1932 — it is only the fact that our national income is high that has created the demand. Civilian psychology is for the greater part attuned to a period of denial and sacrifice — in fact, is far ahead of the moves made in Washington to date. And even if the steel supply were adequate to take care of civilian uses, there could be no facilities or labor for fabricating such commodities without cutting into our war effort. True, some "bottlenecks" developed in certain classes of products, but these are rapidly disappearing under the ingenuity of steel plant engineers and operators.

CAPACITY AND EXPANSION

Coming from the same haunts which a few years ago issued volumes of testimony fulminating against the over-expansion of the steel industry, there now issue forth diatribes censuring the industry for being able to make only 83 or 85 million tons a year — only 30 per cent more than the total capacity of all the Axis dominated countries — only 24 per cent more than was ever produced in this country. Fortunately, the record disputes these philippics. The decade from 1929 to 1939 — surely not the most propitious period — added 10 million tons to our national capacity. And the next two years added another 7 million tons. Nearly $1,100,000,000 (half government funds, half company funds) were expended in 1941 or alloted for 1942 for increased capacity — and 134 companies, representing over 90 per cent of the producing capacity, are expanding or improving their facilities this year.

Under the curtailed expansion plans recently announced, ingot capacity will be further increased by 7,692,000 tons of open hearth and 2,018,000 tons of electric steel. The total capacity by mid-1943 is to be 98,279,970 tons of ingots, made up of 85,799,260 tons of open hearth, 6,721,400 tons of bessemer, and 5,759,310 tons of electric. This should provide a total of 68,796,000 tons per year of finished steel products. The greatest proportional increase is, of course, in electric furnace capacity, which will show a tripling of capacity in a period of less than four years.

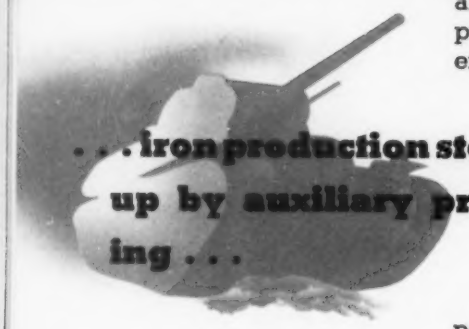
Full use of this new ingot capacity will require over 109½ million tons of metallics, possibly made up of:

Pig iron	60,851,000 tons
Home scrap	26,828,000 tons
Purchased scrap	16,000,000 tons
Metal in ore	5,832,000 tons

This is a sizable bill of goods, and suggests a look at the available supplies of these materials.

BLAST FURNACES

Entering the year with a total annual capacity of 60,394,000 net tons of pig iron, the blast furnaces of the United States have been burdened to capacity and pushed to the limit in the effort to compensate for the dwindling supply of metallics. Tonnage, regardless of cost, is the theme, and no item has been neglected which might increase production. Improvement of coke quality, grading of coke for size, higher blast temperatures, higher blast volumes, ore preparation, blast conditioning — all of these, plus the thousand-and-one pet ideas of the blast furnace men, are in use, and are reflected in a gradually increasing production. The monthly rec-



. . . iron production stepped up by auxiliary processing . . .

ord for single furnace production has been set and broken several times, and has now closely approached the 45,000 ton mark.

One of the most promising items is that of ore preparation, one company reporting that the use of 40-45 per cent of sinter in the blast furnace burden showed 10-19 per cent increase in production, 16 per cent decrease in coke rate, 20 per cent decrease in flux rate, and 50 per cent decrease in flue dust production. Another producer obtained excellent results in increased production and decreased fuel by screening out the fines from certain ores and sintering the fines before charging with the coarse untreated ore. It is estimated that the country's sintering capacity total sabout 13,000,000 tons per year, not all of which is available for high quality operation. It is further estimated that a 1200 ton-per-day unit can be built in six months at a cost of about $600,000, a speedier procedure than building new blast furnace capacity.

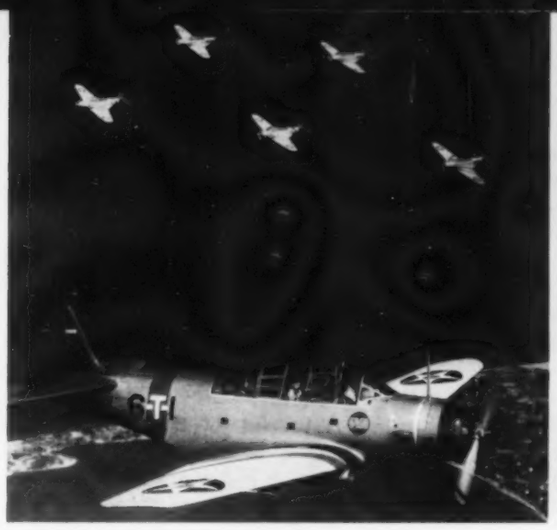
The subject of blast conditioning has been the topic of more arguments than has the responsibility for high chipping, with many blast furnace men hesitating to promise any gain in production through its use. To date, however, there have been 20 installations made, of various types, some capable of reducing moisture to three grains per cu ft and some going down to one grain per cu ft. The only results which have been published to date are from three-grain systems, and have reported increased production of the order of 15-20 per cent in months of high humidity, with 5-13 per cent reduction in fuel rate. There has been some tendency in many quarters to credit some of these showings to other improvements made on the furnace equipment. However, additional results from the installations now working should bring out the picture more clearly. Evaluation of the true worth and most efficient operation of blast conditioning units will be of value to the entire industry and should be done as rapidly as possible. If results justify the practice, every furnace should be, and no doubt will be so equipped.

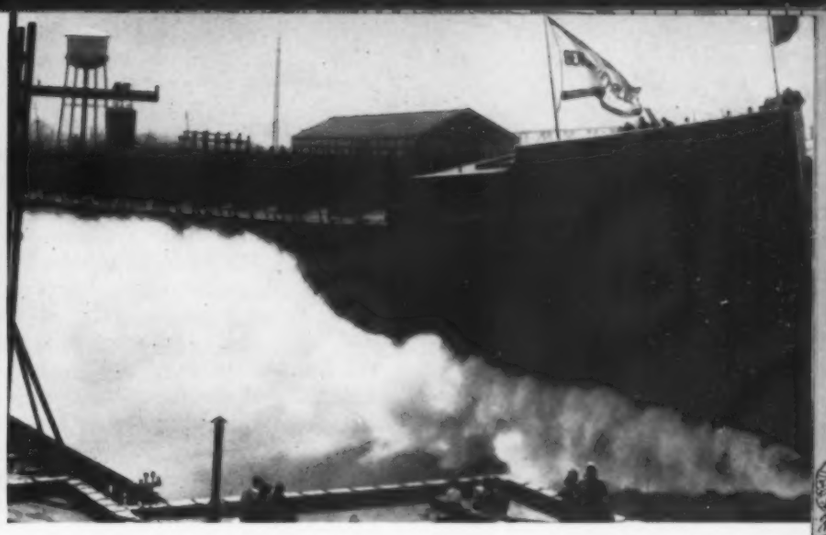
The variation in rates of calcination of fluxes has received closer study in the effort to increase production. Dolomites calcine more rapidly than dolomitic limestone, and high calcium stones are slowest. Calcination is speeded up by crushing the flux to smaller sizes. Some experimentation has been done on the introduction of powdered lime through the furnace tuyeres for slag control with varying ash in the coke. This permits the use of a more acid slag in the bosh, giving faster action.

As now planned, seven new blast furnaces will be added during 1942 and thirteen more during 1943. Plans were in progress for six additional furnaces to go into operation in 1944, but with the recent curtailment of expansion it is uncertain whether these plans will be followed up. The addition of twenty new furnaces will boost blast furnace capacity to about 68,000,000 tons of pig iron per year, and it is expected that another 2,500,000 tons will be picked up by rebuilding and enlarging old furnaces by greater use of sintered ores, etc. this expansion will go far in alleviating the scrap shortage, and is being pushed to completion as rapidly as possible.

In the new furnaces the trend is toward larger stocklines, 20-21 ft, and hearths of 25-28 ft, with 16 or 18 tuyeres. Bosh cooling is kept to a minimum. In several cases old furnaces were moved to supply parts for the new furnaces.

Record production figures have made it impossible to confine sulphur contents of raw materials to the low specifi-





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cations usually desired. Also, blast furnace operation is in many cases speeded up by using leaner slags at the expense of sulphur elimination, using an after-treatment for sulphur reduction. Desulphurizing is practiced at a number of plants to the extent of 50-60 per cent reduction of sulphur in the iron. Several methods are in use, employing soda ash, caustic soda, or a mixture of the two. The practice got off to a bad start because of failure to consider the chemical reactions and physical phenomena, and to supply proper equipment. It is an established fact that sulphur, in either high or low manganese iron, can be reduced from .09 per cent or less to .035 per cent. Properly fed upon the casting stream, 10 lb of granular soda ash per ton of iron will give results somewhat as follows:

Original sulphur content, per cent	Per cent reduction of sulphur
.03	30
.04	40
.05	50
.09	60 or more

With this treatment, it is essential that the slag is well skimmed off, that the metal temperature is high, and that good contact is made between metal and soda ash.

ORE AND COKE

Pig iron calls for ore, and with the step-up of blast furnace operations, it is estimated that about 100,000,000 net tons of iron ore must be shipped down the Great Lakes in 1942, and perhaps 115,000,000 net tons in 1943. To meet this increased demand, new mines have been opened and old workings reopened in Minnesota and Michigan. Additional sources in Wisconsin, Missouri, New York, Pennsylvania, and New Jersey are being worked, where rail shipments will ease the burden on lake shipping. Eastern plants which formerly depended on foreign sources have turned to domestic supply.

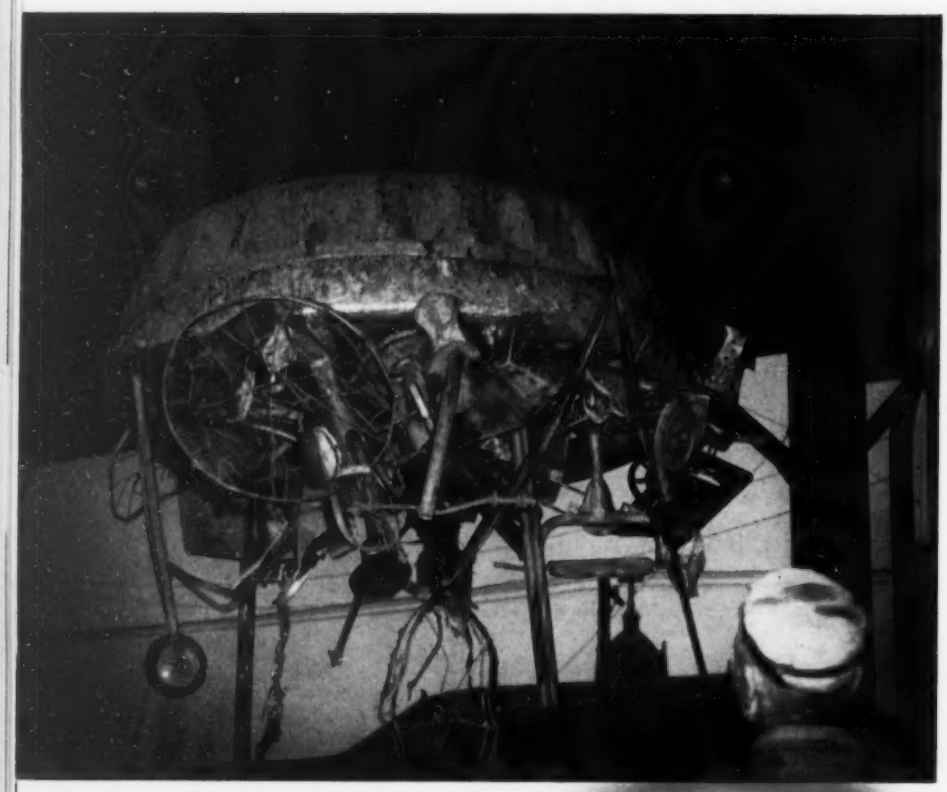
With about 300 ships totaling over 3,000,000 net tons capacity per trip, even a 30-trip season leaves a wide margin between demand and supply. This gap will be bridged by the use of Canadian carriers, by the addition of 21 new large carriers under construction, and by the use of remodeled automobile carriers, etc. Available vessels have been pooled for efficient operation, and down-lake shipments of grain and limestone, which amounted to over 29,000,000 net tons in 1941, have been diverted to rail to a considerable degree.

The trend toward increased beneficiation of ore at the fields continues, and, with the promise of ores higher in silica and lower in alumina, will probably increase. Washing, sintering, crushing, jigging, and magnetic concentration may be used, as dictated by the nature of the ore. Many of the lake ores need partial drying before screening for the separation of the smaller sizes. In 1941, 18.9 per cent of the ore shipped on the lakes was treated, for the greater part by washing.

. . . ore beneficiation to increase as ore quality declines . . .

There seems to be no cause for immediate alarm in the coke situation, even with the expansion in blast furnace capacity, much of which is attended by new by-product coke plants. Present plans call for an expansion in annual coking capacity of 7,083,000 tons, which, added to the existing capacity of about 55,000,000 tons will give a total of approximately 62,000,000 tons per year in the steel plants. Another 10,000,000 tons per year is available from bee hive ovens and from merchant by-

product ovens. A fact worthy of consideration, however, is that approximately 10 per cent of coke oven production is from bee hive ovens, with a resultant waste of valuable by-products. Some of these bee hive plants are faced with the necessity of obtaining new sources of coal, as the veins adjacent to the plants will be worked out. It is essential for continuity of an adequate coke supply that these bee hive ovens be kept in production.



American steelmakers have become accustomed to using scrap as a highly important ingredient in the brewing of steel, and their production methods have been geared to its use. Now, however, extended demand for steel and war production's tendency to remove scrap from normal circulation have combined to work a disappearing act worthy of Punjab on our scrap piles.

A recent statement from the American Iron and Steel Institute covering scrap consumption shows that the steel plant inventories decreased almost 2,000,000 tons during the past 18 months. The decrease in 1942 is at an accelerated rate, and the situation appears ominous.

Home scrap, produced in the steel plants themselves, remains approximately constant at about 28 per cent of production, or about 25,000,000 tons per year, except as influenced by the export of steel ingots. The remaining 20,000,000 tons needed for usual peak operation must be purchased from a supply which has been reduced by curtailment of automobile and other civilian production, by conservation of old equipment by railroads and industry, and by the low return of scrap from war industries and lease-lend shipments. Although there have been numerous temporary shut-downs of open hearths due to localized scrap shortages, the demand has as a whole been met so far, but the shortage is becoming more acute. Much of the present scrap output is from non-recurrent sources, and ceiling prices have cut the incentive to the collector. To shore up steel production and keep shut-downs to a minimum, the steel industry, the scrap industry, and various government agencies are exerting every effort to bring out more scrap. Non-stop drives have begun, in homes, farms, communities, and industry, and while the results have been something less than startling, there is no denying that a great reservoir of scrap still exists in various forms of little used or non-essential items which could be scrapped should the squeeze grow tight enough. Automobile "graveyards" are at present yielding about 350,000 tons of scrap per month, and the steel industry is financing an extensive advertising campaign devoted to bringing out the scrap, but it is doubtful if enough will be forthcoming to maintain the present rate of production through the winter.

It has been estimated (just how accurately cannot be gauged) that warehouses and other inventories throughout the country contain approximately 16,000,000 tons of steel, much of which is stated to be inapplicable to the present demands of industry. If this is true, perhaps we should give serious thought to this stock as another source of scrap steel for the production of more vital types.

A considerable waste of scrap goes on in the form of old tin cans, which are not salvaged to the extent that they should be. Some grades of steel will ab-

sorb considerable tin without damage to the product, while others are very sensitive. Tinned scrap should be segregated and used where .10-.15 per cent of tin is not injurious. It is estimated that of 2,500,000 tons of tin cans used annually in the country, 1,000,000 tons could be economically collected and de-tinned, and several de-tinning plants have been constructed. Much confusion has resulted, however, due to inadequate information concerning the proper preparation and disposition to be made of the cans by the householder in the different areas.

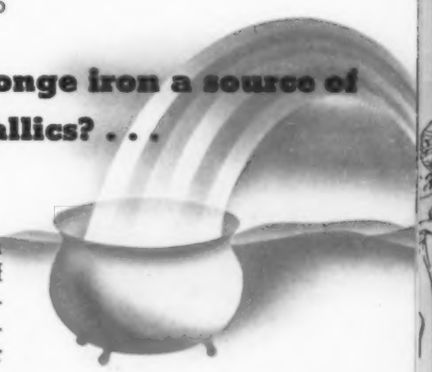
The waste of former lush years is proving of value at present, in the form of reclaimed skulls and other metallic refuse in old slag dumps. Extensive mining and picking operations, with magnetic separation in some cases, is bringing a considerable amount of precious metallics to ease the growing ache caused by the scrap void.

Effective segregation of alloy scrap has contributed to the conservation of the various alloys.

As a means of off-setting the scrap shortage a rabbit has been pulled out of the hat in the form of the age-old but ever recurrent sponge iron reduction process, that pot of gold at the end of so many theorists' rainbow. Here Congress really "went technical." Unhampered and undaunted by a regrettable lack of engineering and industrial talent, senators loosed floods of techni-oratory containing information as accurate as a German propaganda broadcast. Defining sponge iron as "the iron which is produced by melting iron ore in a roaster instead of in a coke oven," and visioning a sponge iron plant "at the mouth of every iron mine in the country," the general trend of this redundant verbiage seems to be that the "concentrated control over the iron and steel industry" has selfishly and perniciously suppressed the development of sponge iron processes, to the detriment of everyone concerned.

Congress has provided the Bureau of Mines with $600,000 for the development of sponge iron processes. In July the Bureau announced a project of two pilot plants, to investigate two methods of production. The War Production Board, under pressure to provide for the construction of sponge iron plants, requested a report on the subject from the National Research Council of the National Academy of Sciences. This report, briefly summarized, indicates that sponge iron is an inferior substitute for steel scrap or for pig iron, that the processes for its production are costly, inefficient and undeveloped, and that the development would be inadvisable and a retardation of the over-all war effort.

. . . sponge iron a source of metallics? . . .



However, it seems safe to say that some activity will ensue along investigational lines before the subject is allowed to lapse again into the state of somnolent lethargy from which it is periodically dragged to the accompaniment of lightened pocketbooks and bruised enthusiasm. Let it suffice to state that the industry is not depending on sponge iron processes to overcome the shortage in metallics.

To alleviate the scrap situation some plants have resorted to the use of blown metal in a duplexing process. One plant where a 25 ton acid converter has been installed at each end of the open hearth floor reports a gain of 40-50 per cent in open hearth production through the use of a charge of 20 per cent scrap and 80 per cent blown metal of 1.00-1.25 per cent carbon content. Duplexing does not reduce the quantity of ore reduced

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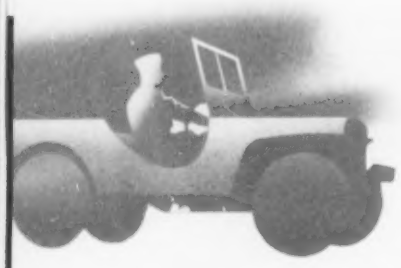


in high iron open hearth heats, and therefore does not give much increase in metallics, although the use of ore to cool the blow in place of pig iron or scrap may give 2½ per cent increase, and possibly more with careful control of the air volume in early stages of the blow.

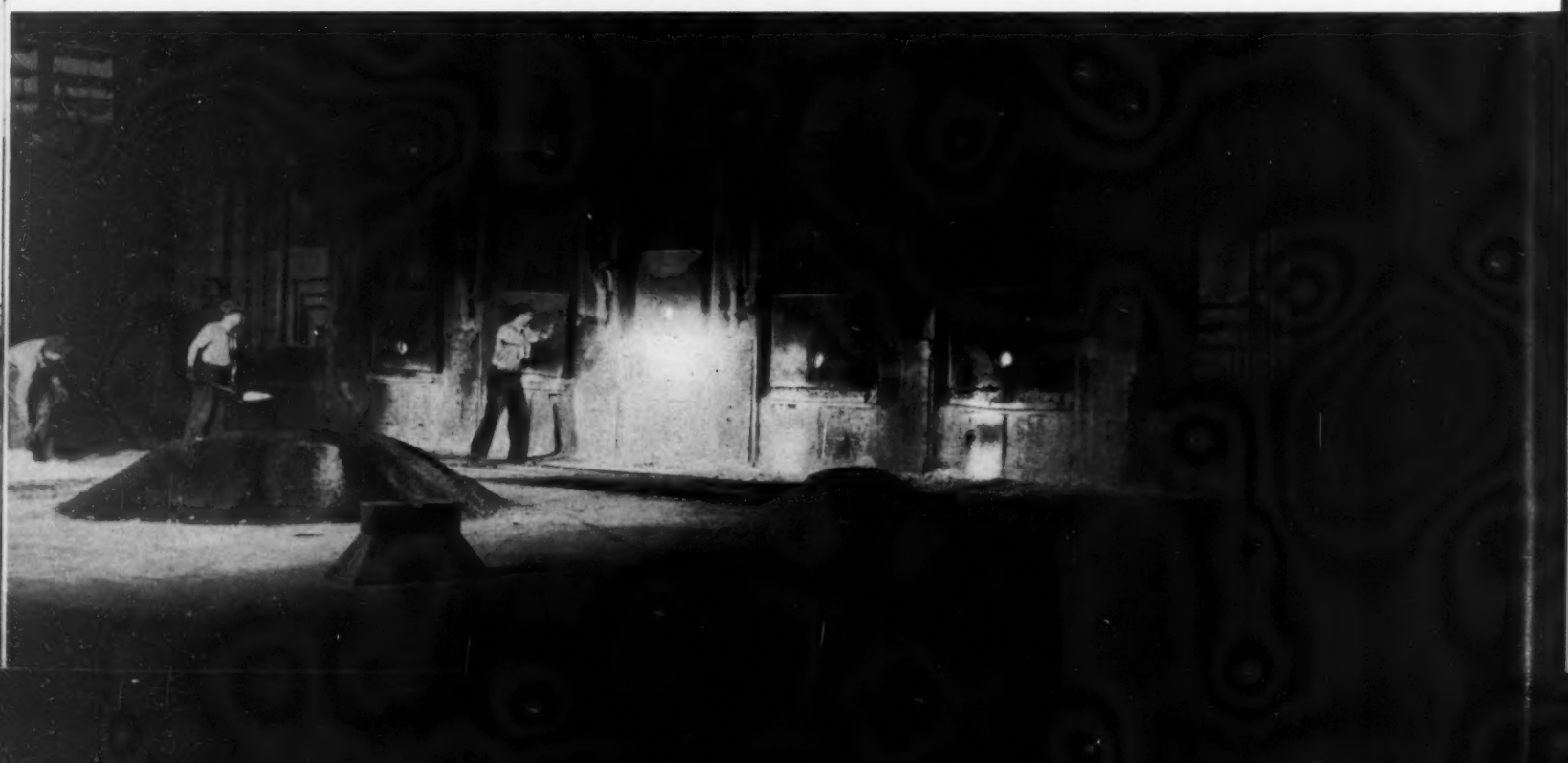
OPEN HEARTH

Recognizing the fact, however, unwelcome, that the scrap situation is driving them to higher iron charges, open hearth operators have approached the problem in various ways, according to their own plant conditions. Several plants have been able to use 70-75 per cent iron in the open hearth charge, thus making the plant practically self-sustaining and requiring almost no purchased scrap. The industry as a whole, however, is far below this figure.

In using a high iron charge the preferable procedure seems to be to spread the limestone evenly over the furnace bottom, perhaps preceded by a little light scrap to prevent the stone sticking to the bottom. It is important that a low volume of tap slag be used on high iron charges if a satisfactory production rate is to be maintained. The use of a 5 per cent limestone charge seems to be favored. Next, iron ore is charged directly upon the limestone, taking care to cover the stone evenly and completely, as it is essential that the lime be kept out of the liquid system until after the slag flush is completed. The scrap is then charged as rapidly as possible, and brought up to at least the temperature of the hot metal, which is then rapidly added. Shortly after this the run-off slag foams up and is flushed off as soon and as thoroughly as possible.

The preferred ore charge is lump ore, one inch or more in size, but this is a scarce commodity. Sintered ores have been applied in lieu of lump ore with good results. A magnetite sinter has been used successfully in 80 per cent hot metal heats. A dense sinter is favored, and has been produced in one case by mixing 10 per cent of roll scale with the ore, adding some limestone, and increasing the fuel input and the draft on the sintering machine. Another plant briquets soft ore by adding one per cent of portland cement, mixing, packing in a jarring machine, and drying. A process showing considerable promise employs a rotary cement kiln, fired with powdered coal, to produce nodules of soft ore. Limestone screenings (about 8 per cent) are mixed with the ore. The product is in the form of dense granules up to the size of a walnut, and contains about 4 per cent lime, which is useful in fluxing. A considerable quantity of this nodulized soft ore is being made in the Pittsburgh district, and seems to perform as well as lump ore.

The possibilities of the use of soft ore, as determined by a recent series of investigations, seem to be dependent on the moisture and silicon content of the ore, as well as its size. It has been found that a maximum moisture of 7 lb of water in the ore per ton of ingots is desirable, although this may be increased somewhat by sandwiching layers of ore and scrap. Likewise, 15 lb of silicon in the ore per ton of ingots may be taken as a maximum. With an ore having a 3 per cent ignition loss and 7 per cent silicon, 200-300 lb of ore can be used per ton of ingots with 61-65 per cent hot metal



charges. With an ore having an ignition loss of over 5 per cent, hot metal charges must be held down to 55 per cent. Above these figures lump or prepared ore must be used if blowing is to be avoided.

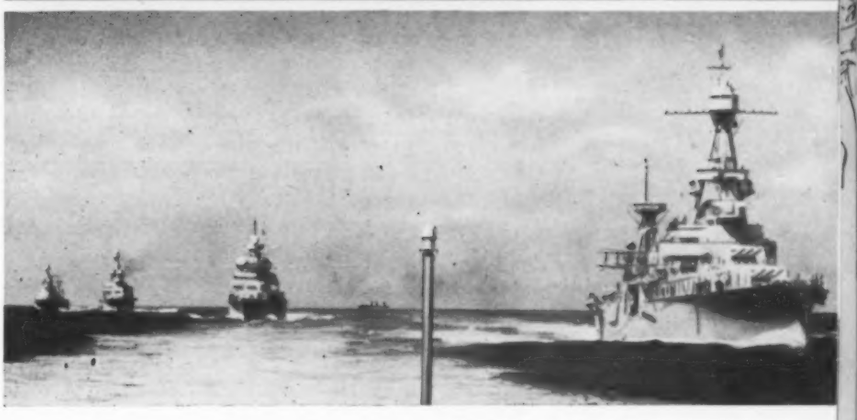
High iron charges naturally mean high ore charges, running from 5-10 per cent of ore with 60 per cent of iron to 12-15 per cent of ore with 80 per cent of iron. This use of larger ore charges is naturally beneficial from the standpoint of increasing the supply of available metallic material. Various methods have been advanced in order to increase the amount of ore reduced in the open hearth: the charging of carbonaceous material with the ore, which has shown reduced yield and tonnage; cutting the limestone charge to about 3 per cent, replacing the oxygen released by calcination of the stone by oxygen from the increased ore charge and using burnt lime deficiency; using all burnt lime, requiring extreme care to keep the lime from coming up before completion of the run-off.

Furnace repair and rebuilding delays have been reduced in a considerable degree by the use of rammed furnace bottoms, quick-setting materials, improved furnace design, etc. Efforts are being expended to eliminate the characteristic slowing down of open hearth furnaces near the end of a run. Various machines are in use for rapid determination of the various metalloid contents of the steel.

ALLOYS

The quantitatively lesser but qualitatively important elements of the steel making processes continue to give producers nauseous headaches. Manganese, chromium, nickel, tungsten, vanadium, molybdenum and aluminum must all be conserved, and no longer can the metallurgist complicate matters by adding a dab of this or that without first reckoning very closely. In all of these materials, domestic production is in the throes of expansion, but the interval between here and there must be bridged by stretching our stockpiles. Some of the materials are very scarce and others tight only because of their use in place of the scarce ones.

When the scarcity of alloying elements required for the production of high quality steels became apparent, divers substitutions were suggested and tried — all of which were reminiscent of Shaw's statement that "Science . . . never solves a problem without creating ten new ones." Substitution for the substitutes became necessary. As a result of some excellent committee work, the simplified A.I.S.I. standard list of 87 alloy steels was further reduced to 16 basic compositions of National Emergency steels to conserve alloying elements. This list has been used in some WPB specifications for several months. However, it was increasingly obvious that further alloy conservation was necessary, and a new series containing 18 basic compositions (47 specifications) was accordingly devised and brought out in August. The new list shows reduced nickel and molybdenum, and adjusts the use of silicon and manganese to offset these reductions. Greater use of residual alloys in scrap (which have almost doubled in the past few years) is aided by the use of a larger number of alloys in the specifications, tending to give more efficient recovery. The further adoption of the NE steels should be pushed. It is believed that a further wholesale substitution of carbon steel for alloy steels will be required, and thiscan no doubt be effected



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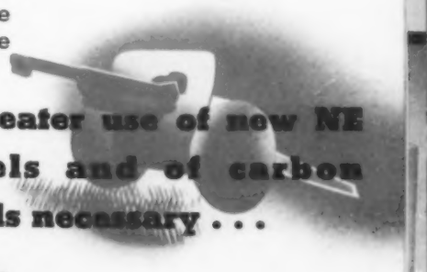


without too great sacrifice if exact heat treating is provided.

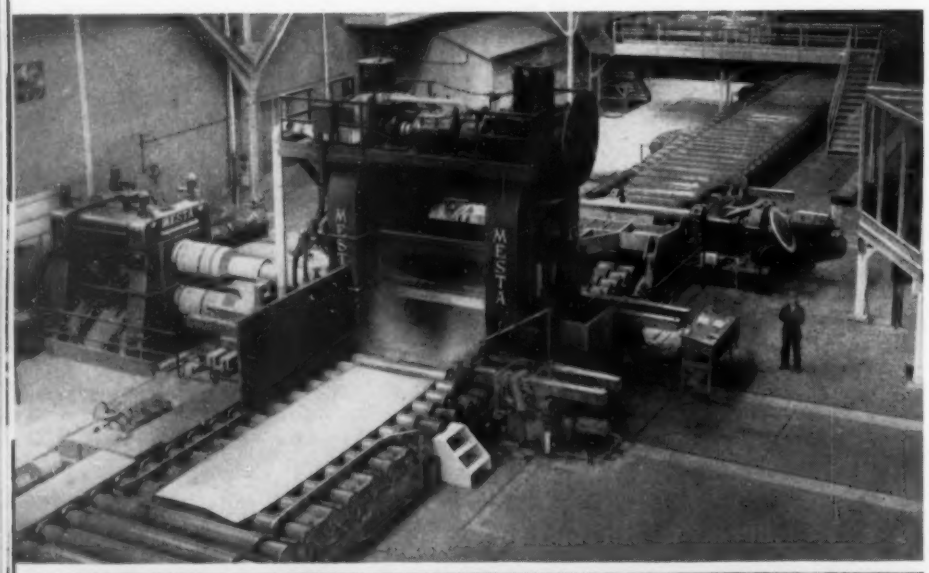
Effective slag and furnace control in the open hearth has done much to conserve alloys. Standardization and the elimination of many special analyses have improved the efficiency of open hearth operation and resulted in fewer off-heats.

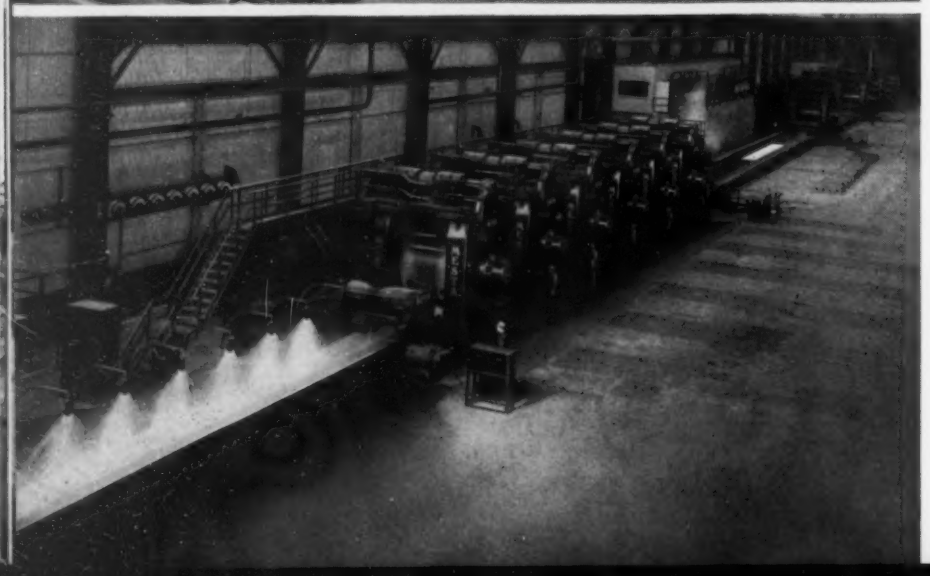
PLATE

A year ago, one of the gravest threatened shortages in the war effort was that of plate material. Existing plate mills, with a capacity of somewhat less than 600,000 tons per month, were greatly inadequate. Here was a bottleneck of serious proportions, apparently remediable only by a long range building program of new plate mills, requiring much time and money. But such reckoning failed to consider those modern giants built within the last decade, and often condemned as technological monsters — the continuous wide strip mill. Here were 28 fine mills of various sizes, of which at least half could be converted to the production of plate 3/16-1 in. thick. Many of these mills had, out of curiosity, rolled a few pieces of 3/4 in. or 1 in. plate, but they were not primarily designed for the purpose. However, their conversion offered the quickest solution of the problem, and was begun immediately.

The changeover required some rearrangement and additions of mill tables and transfers, heavier shearing equipment, additional leveling and finishing equipment, etc., the alterations depending on the original layout of the mill. With typical steel plant ingenuity, many of these changes were effected through the use of various odds and ends of equipment gathered from all over the plant, and rebuilt to suit the purpose at hand. The production of plate also required additional space for the finishing operations, requiring building extensions in many cases. One plant solved this problem by moving the hot plates in cars of special construction a distance of six miles to another plant where space was available for finishing equipment.

The expediency with which this conversion was made is clearly shown by the fact that in July, 1942, out of a total of 1,124,118 tons of plates produced, 550,537 tons were rolled on the continuous strip mills. This figure is approximately in agreement with the potential plate capacity as estimated for these mills by Arthur G. McKee in his address before the Cleveland District Section of the Association of Iron and Steel Engineers (Iron and Steel Engineer, January, 1942). However, it is felt that full use of these mills has been retarded to some extent by delay in obtaining equipment required for complete conversion, and that their plate production will reach higher figures.





TINPLATE

Electrolytic tinning, for years generally considered more or less as a scientific plaything, has become the belle of the industry since the little yellow men blitzed most of the world's tin sources. This process, which fortunately had been developed by some far-sighted producers to a stage beyond the experimental, can produce a satisfactory tin coating of about .4 lb per base box as against the 1.5 lb coat usually applied in the hot-dip process. With our tin supply limited to 14,000 tons to be smelted per year in Texas from Bolivian ores, imports of perhaps 9,000 tons of refined tin from

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Africa, and perhaps a few thousand tons to be reclaimed through the more or less confused de-tinning program, plus a stockpile which unfortunately must supply most of the 1942 requirements, this saving is welcome and essential.

By a careful survey of the 3½ million tons of tin mill product which has been estimated as the 1943 requirement, it has been possible to apply black plate to 8 per cent of the requirement, chemically treated plate to 13 per cent, and electrolytic tinning to about 40 per cent, leaving 39 per cent still to receive the heavier coating given by the hot dip process for the more exacting applications. This schedule can be covered by the tin supply now visible.

Thus, the program calls for 1,400,000 tons of tinplate to be electrolytically coated. To carry out this plan, the industry has approximately 27 electrolytic tinning lines built or building, which, with the half-dozen original installations, will provide adequate capacity. The newer lines will average about 50,000 tons per year of tinplate each, and cost about $1,000,000 apiece. Processes vary somewhat as to the type of the electrolytic bath and the mechanical design of the units. Baths may be alkaline or acid or a combination of the two, while the units may be constructed in one straight continuous line, or may be split up into several functional lines. Most of the new installations are divided up among four main plating processes.

Present plans also call for the installation of about 20 chemical treating lines, all based upon a patented process using a fine phosphate coating to prevent rusting and to furnish a bonding medium for subsequent lacquering. These lines cost about $300,000 each, and have an individual capacity of about 20,000 tons per year.

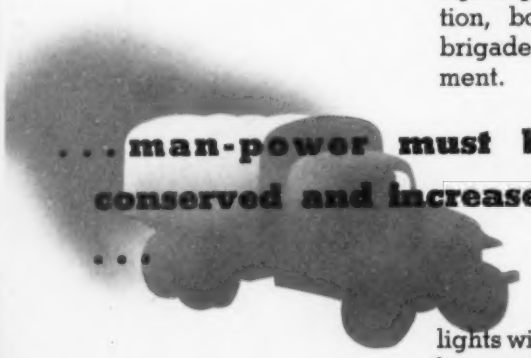
TRAINING AND MISCELLANEOUS ACTIVITIES

Not the least of the problems of the industry has been the expansion of the working force to the point required by record-breaking production. Beginning early in 1940, the steel industry has to date added more than 145,000 employes to its rolls. This addition has placed a tremendous training burden on the various companies, and was reflected in a rise in the man-hours required for production, the figure rising from about 12.9 man-hours per ton of ingots to a peak of 13.7 in the middle of 1941.

Though training programs of various sorts existed in the industry for years, their scope has been increased greatly. Foremen are participating in organized programs of supervisory development training, using various media such as lectures, conferences, panel discussions, motion pictures, etc. Young college graduates are put into rotating positions which carry them through a number of positions giving job experience for development purposes. Regular four year trade apprentice courses are also in use, in the various crafts employed in the industry, combining job experience with related instruction in either company or public classrooms. The employment of helpers or learners has been effective in training workers for other production and maintenance positions. A great portion of the effort has been directed toward job training programs for new employes, for employes whose work has been changed in character, and for employes preparing for up-grading and advancement. How well the idustry has met the training problem is well illustrated by the fact that the man-hour figure has dropped back to about 13 man-hours per ton of ingots.

Practically all of the steel plants have developed plant protection plans designed to meet every emergency which might result from air raids, sabotage, etc. These plans have been carried out more extensively in plants located in what might be termed critical areas, but in all cases a great number of employes have been thoroughly trained in some phase of protective work, a distinct service to local civilian defense organizations.

Protection plans have been designed to keep the maximum number of men at work during any emergency so that interruption of production may be kept to a minimum. Most of the set-ups follow in general a common plan, with a coordinator, who may or may not be the plant manager, at the head of four main groups: fire, maintenance, medical, and police. Departmental wardens are appointed and trained in first aid, fire fighting, gas detection and decontamination, bomb handling, etc. Emergency brigades are organized in each department.



In general, air raid precautions call for plant black-out in case of alarm, during which no casts or taps are to be made, furnaces will be shut down or shielded, rolling will cease, and lights will be turned out. Air raid shelters have not been constructed to any extent, but every plant has a number of cellars and tunnels which can be turned to this use.

To conserve man-power and material resources for war production, the long continued safety campaigns in the industry have been conducted more actively than ever before. Because of the high operating rate and the large number of new employes, accident frequency increased in 1941 to 7.02 per million man-hours from the 1940 figure of 6.54. This increase is lower than the average of all industries, and steel last year placed third in safety among 31 major industries.

Personnel departments have also labored to prevent the loss of productive man-hours through the use of miscellaneous services designed to keep the employe well and happy. This may usually include some limited medical care, legal service, financial advice, or almost any type of service which might help to keep the man on his job.

Joint management-labor committees have been established by all large producers in compliance with the WPB's request. Through posters, meetings, suggestion boxes, and other mediums, not entirely new to the steel industry, these committees endeavor to spur production, and have received considerable press agentry along that line.

In approximately 150 steel producing companies, including all of the large producers, payroll deductions for war bond purchases are made from 95 per cent of the employees. The total of these deductions is gradually increasing and is now about 10 per cent of the total payroll.

CONCLUSION

The strength and efficiency of the steel industry are not merely coincidental, but the result of the foresight and progressiveness of men engaged in the industry — virtues which are part and parcel of private competitive enterprise.

By the very nature of its processes, steel business is big business. Operating units are large and, for efficiency, must be integrated. Hence, huge investments in plants, equipment and material reserves are necessary, as is a large working capital. Yet, despite the fact that actual ownership of these large corporations is spread among thousands of small stockholders — just as the right of self-government is spread among the millions of voters in a democratic form of government — they are abused and vilified by every Jack-in-office who thinks that venting spleen against "big business" is a grand slam in votes. With everything else approaching astronomical proportions, it's about time to cease

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stigmatizing business because of its magnitude — it's about time to recognize and insofar as possible ease the plagues of industry rather than add to its burden. Even the devil deserves his dues. Unbiased observation can lead only to the conclusion that the steel industry is doing a difficult job magnificently under radically unusual circumstances, and it is striving to continue and to exceed its past performance, even though at times compelled to forego certain rights and to accept certain inequitable ultimatums in order to avoid interruptions in the flow of its product, so essential to the modern mechanized warfare. Should all facilities, agencies and resources of our country be doing as well as is the steel industry, we could look to the future with fearless confidence.

Now . . lets look at the Record

. . . On the following pages are a number of reviews setting forth the efforts and progress of individual steel producers. Each carries its own tale of fine cooperation, of splendid achievement, which, combined, indicate the steel industry's contribution to our overall war effort . . .

National Steel Corporation

By E. T. WEIR

CHAIRMAN OF THE BOARD

▲ EXCEPT for the obvious step-up in activity, anyone unfamiliar with the steel industry would probably see little difference in the industry as it is now and as it was before the war. The steel industry turns out the same general product and with the same general types of plant and equipment. Yet in gearing themselves to war production, steel companies, in many cases, have overcome more difficult obstacles than other industries, even including those which were compelled to solve war production problems by building entirely new, special purpose plants.

The war emergency has confronted individual steel companies with three major requirements: 1. To increase the overall quantity of steel produced. 2. To increase the production of certain materials far beyond the requirements and facilities of peacetime. 3. To manufacture special products not previously included in regular production.

National Steel Corporation's program to meet the war demands for steel started more than a year before Pearl Harbor and has extended into every department of every plant. Late in 1940, our management anticipated the large increase in the requirements for pig iron which later developed and plans were effected then to add substantially to blast furnace output. The blast furnace project included the building of two entirely new large type furnaces with all auxiliary equipment and the rebuilding of a third furnace. The new furnaces were constructed at the plants of the Weirton Steel Company and Great Lakes Steel Corporation while the rebuilt furnace is at the Hanna Furnace Corporation plant. As a result of these additions, the pig iron production of National Steel Corporation has been increased approximately 60 per cent.

Other plant expansions at Weirton included the completion of a battery of 45 coke ovens, complete with a by-product plant, which has resulted in the additional production of 750 tons of coke per day and a substantial increase in the output of tar, ammonium sulphate, benzol, toluol and other by-products. Also completed was the No. 2 bessemer converter which has made possible a 17 per cent increase in steel production. Fifteen new barges for transportation of coal and coke have been purchased and additional new equipment has been installed at the Isabella mine to increase coal production for the coke ovens.

At Weirton there have been numerous installations of equipment for new processes directly related to the war effort. New equipment has been added in the open hearth and blooming mill. Three electrolytic tinning lines are being installed, and in addition, an experimental electrolytic line is being converted to a production line. The electrolytic method makes possible a substantial reduction in the amount of tin required and a further step in conservation of this vital metal has been taken by installation of equipment to produce bonderized black plate which, in some applications, can replace tin plate. Equipment has also been added for production of cold rolled cartridge clip steel, for rolling copper clad steel, and for punching, annealing and cleaning of bullet jacket cups.

At Great Lakes one of the most important plant additions was the installation of a 3/8 in. plate shearing line as auxiliary equipment to the 96 in. continuous hot strip mill. This line is capable of levelling, shearing and finishing car plates, ship plates and armor plate in sizes up to 90 in. width, 3/8 in. in thickness and 30 ft in length. Also constructed or in progress are a new sintering plant for the production of about 900 tons of sinter per day for use in both blast furnaces and open hearth furnaces; a Dorr thickener that will reclaim approximately 150 tons of wet flue dust per day, and an air conditioning unit for the blast furnaces. A new slab yard and building are being built to be used primarily for the treatment of armor plate slabs and shell steel blooms. Equipment will include picklers, scarfing machine, billeteers and heavy round straightener. Due to a heavy increase in the production of alloy steels, facilities of the physical testing laboratory have been doubled. New locomotives, cars, a locomotive crane and other auxiliary equipment have been added.

The expansion at Hanna Furnace Corporation included the construction of a boiler plant consisting of five 500 hp boilers and the installation of a new 2-strand pig casting machine.

Modernization at Weirton included the rebuilding of 136 beehive coke ovens complete with auxiliary equipment for the additional production of 340 tons of coke per day and the rebuilding of five 7500 kw and of two 3000 kw turbo generators. Great Lakes Steel Corporation has rebuilt a 5/16 in. shearing and cutting line and equipped the unit with a piler table. The unit is capable of leveling, shearing and finishing car plates, ship plates and armor plate up to 5/16 in. in thickness, 90 in. in width and 30 ft in length. Cars, cranes and other miscellaneous equipment have been installed in the open hearth department to handle increased quantities of alloys used in the manufacture of armor plate and shell steel. As part of a modernization program at Hanna Furnace Corporation, two steeple type blowing engines and a two-pan sintering plant were rebuilt.

New Records

New records have been established in every major operation in National Steel Corporation and in the making of these records, countless subdepartment records have been broken. This accomplishment can be attributed to high efficiency of plant and equipment and to the excellent cooperation of the entire organization. These records are too numerous to mention in detail but some are worthy of special note.

All known records were broken for construction

time in the building of the new "B" blast furnace at Great Lakes Steel Corporation. This furnace replaced an old furnace of smaller design which was blown out on June 1, 1941. The old furnace, including the foundation, was completely dismantled and on its site the new furnace was constructed and blown in on December 8, 1941, a period of only six months and one week. This construction record was followed by a new world record for the production of pig iron which was established by this furnace in March, 1942. In this month the furnace produced 43,478 net tons of pig iron while the largest amount produced on a single day was 1,608 net tons.

In March 1942 also, a new record was established by the open hearth department at Weirton. A total of 153,823 net tons of steel was produced in the 31-day period, an increase of more than 13,000 tons over the previous high mark. Additional pig iron from the new blast furnace and the use of the bessemers to produce synthetic scrap were contributing factors which made this record possible in the face of the highly adverse scrap situation which prevailed then and since.

Although all departments are working under extreme pressure to produce record-breaking tonnages, time lost in operations has been held to a minimum. This is due to the high physical efficiency of the mills and to careful planning on the part of the entire organization. Through posters, meetings and other means a continuous effort is made to impress upon each employee the importance of his being on the job when scheduled and of his conserving time wherever possible.

The only "bottle-necks" in our operations are those caused by the scarcity of certain materials necessary to the production of semi-finished and finished steel. New equipment has been installed where necessary to provide for the special requirements of the national emergency and by careful planning the occurrence of "bottle-neck" situations has been avoided. Certain types of material, for instance, are identified by means of a color system and special tracers, or expediters, are assigned to follow these steels through the mills and keep them moving.

The situation with regard to changes in the type of products is mixed. In some cases, products are the same as before the war although they are now being applied in war production. There has been a change in much of our production from a tonnage standpoint, however, and many special products have been added to our normal production expressly to meet war requirements.

An outstanding development, and one of which we are proud, has been the production of low alloy steels by the open hearth method suitable for many exacting ordnance uses. Our 9100 series of low alloy steels, produced in this manner, is being applied in the manufacture of tanks, armored vehicles in gun and howitzer carriages and mounts, jeeps, trucks, airplanes and a wide range of other ordnance equipment. The advantages of these low-alloy steels produced in this manner are apparent. Only on a production basis can alloy steel be provided in quantities commensurate with the needs of this war. In addition, open hearth production of low alloys conserves critical materials and releases the product of the electric furnaces for other essential uses.

Another important product change was made through the adaptation of our 96 in. continuous mill at Great Lakes for the rolling of steel plates. This mill was originally designed and used for the production of wide sheets and strip only but new equipment has been added and the mill is now rolling a large monthly tonnage of steel plates to supply the needs for this material in ship building and other war uses. Plate shearing and handling facilities were installed at a cost of approximately $2,000,000 and since the first of this year, a very high percentage of our shipments have been in carbon alloy plates and armor plate.

Special products that have been added to normal production at Weirton include: billets for shell steel forgings, cold rolled strip steel clip stock for automatic rifles, cold rolled strip steel for metallic links for machine guns, cold rolled gilded strip steel for bullet jackets, hot rolled strip steel for shell casings, and low alloy, high tensile structural steel for use in tanks. Semi-finished steel has been provided for lend-lease requirements.

Employee Training

Employee training is important at all times both to the employee and to the company and is given appropriate attention. This normal need, however, has increased in proportion to the volume and type of activity created by war conditions. Our program ranges from pre-employment training, which gives prospective employees the opportunity to prepare themselves for specific jobs, to courses of college level which enable present employees to increase their knowledge and skill. The training program has three major subdivisions: vocational, upgrading and job instructor training. The vocational portion of the program includes pre-employment training, supplemental training, which offers courses related to the jobs on which employees are working, and refresher training, which enables employees to learn a new trade or to brush up on a trade in which they have had past experience. Upgrading training is designed to enable men to move up on various jobs as they become more proficient. Job instructors training is given to selected members of the supervisory staff who, in turn, serve as instructors of other members of the staff. This course is designed to equip supervisors for the more efficient instruction of new employees in their work. As a further step in training, new employees are assigned to work with older and more experienced men for training and instruction. Certain departments have definite apprentice training programs which cover three or more years. Some of the training programs are given in cooperation with colleges in the vicinity of our operations. Our employees are encouraged to take advantage of these various opportunities for self-improvement.

The safety programs of National Steel Corporation subsidiaries vary to some extent in the manner of organization but in all cases our companies rank high

on safety lists. In the first six months of 1942, Weirton Steel Company, as an example, had an accident frequency rate of 2.63 which compares with an average frequency rate of 7.2 for the steel industry in 1941. The protection of the employee starts with his employment. He is equipped, at company expense, with the most modern safety equipment designed for his particular job. Before he starts work, he is given detailed safety instructions by the safety manager or by the superintendent of his department. Safety managers and inspectors are constantly in the mills to check violations and to discover possible hazards. Frequent meetings, in some cases daily, are held to analyze safety conditions and plan improvements. At Weirton, safety talks are broadcast over a loudspeaker system at the change of each turn.

At the suggestion of the War Production Board, Labor-Management Committees were formed in April of this year. The committees meet regularly and discuss proposals designed to expedite production. Suggestions from employees throughout the organization are carefully considered and where practical are put into effect. The committees also assist in plans to aid the war effort such as arrangements for "share-a-ride" transportation and the distribution of posters and literature to stimulate production.

The most serious limitation on steel production is the situation with regard to steel scrap. This is due not only to the scarcity of scrap but also to the poor quality of such supplies as are available. The deficiency in scrap has been offset to an important extent by the increased tonnage of pig iron and the use of bessemer converters to produce synthetic scrap. Nothing could now contribute so much to the production of steel for war, however, as an increase in the quantity and a substantial improvement in the grading and preparation of steel scrap.

Granite City Steel Company

By Hayward Niedringhaus

PRESIDENT

▲ IN normal times, Granite City Steel Company is equipped to produce a complete assortment of flat rolled steel products varying from heavy plates over one inch thick to light gauge sheets 6/1000ths of an inch thick. The company is equipped also with galvanizing and tinning facilities and with other particular equipment for manufacturing specialty steel products, such as electrical sheets and porcelain enamel sheets.

In the present emergency, however, the requirements of the war program are largely for heavy gauge commodities. Because the company's hot strip mill is well suited to the manufacture of plates in widths and thicknesses required for shipbuilding purposes, this heavy gauge product demand has reflected itself for us in a very substantially increased production of plates, the greatest proportion of which is being delivered to the Maritime Commission for cargo ships and the Navy Department for special types of vessels. The company's current plate production is over three times its rated capacity to make this product and four times its normal production in peace times. Plates now account for two-thirds of the company's total output, whereas normally they would represent but a fifth.

Because the company's raw steel capacity is fixed, increased plate production has been attained only by reducing the production of light gauge and specialty steel products. Operations in the company's galvanizing department were discontinued completely the first of the year and cannot be started again for the duration. The production of sheets on our hot strip mill is but a fraction of normal production; operations in our sheet mill department are one-third of capacity. The reduced sheet production has reflected itself in turn in the decreased operation of pickling, annealing, cold rolling, and other finishing departments. For the first half of the year the demand for tin plate was heavy, and the company was allocated sufficient pig tin by the government to produce this product in large quantities. Allocations for the last half of the year will reduce this production considerably.

It is apparent, therefore, that while the company's total production has continued at capacity rates, in place of making a wide assortment of products we have been producing essentially two, plate and tin plate, and that instead of selling to a wide range of customers we have been supplying the requirements of but one; namely, the government and its agencies or contractors.

To contribute as fully as possible to the war program, therefore, the company's present activities have changed radically. In addition, other important steps have been taken as a result of the demands imposed by the emergency. Most important of these are the following:

1. Early in 1941 when it appeared the pig iron shortage would become acute the company urged and was instrumental in putting into operation one of the two blast furnaces formerly owned by the St. Louis Coke Company and now operated by the Koppers United Company. A pig iron supply was thereby assured for the company within its own district.

2. Early in 1941 when the industry was circularized for suggestions to increase capacity, the company submitted several proposals. The first incorporated operation of the company's blooming and bar mills, idle due to insufficient ingot capacity, and increased plate capacity. Due to the urgent need for plates, the government recommended the company increase its capacity for producing this product. This program which will cost an estimated $10,500,000 will increase the company's ingot capacity 300,000 tons per year from which 190,000 tons of ship plates will be produced. The completion date has been moved ahead from July to January 1943.

3. The company is now installing and expects to have in operation by the end of the year equipment for the production of electrolytic tin plate. Tin coating on sheets by the electrolytic method is considerably less than the coating required by the hot dipped tinning process. The company's new unit will have an annual capacity of 60,000 tons. The installation was requested by the War Production Board in the interests of pig tin conservation. The project was company financed, as was the installation of a semi-continuous pickling line which electrolytic tinning requires.
4. At the request of the government the company has been experimenting with the production of a steel for use in shell casings to replace brass.

During 1941 the all-time production record of the company's open hearth furnaces was broken six times. The scarcity and inferior quality of scrap has prevented any further record-breaking performances in ingot production so far this year. Plate production each month this year has reached unprecedented high levels, made possible in part by transferring to this department cranes and similar equipment formerly used but not now needed in other departments of the plant.

The company has and will continue to exert every effort in the government's all-out war program. Much of our equipment has been run for over a year at a rate hitherto thought impossible to reach and maintain, but due to the company's established policy of maintaining the plant in the best condition, strain on equipment has been minimized. Efforts are being made continually to increase our present production rate so that we may contribute in a still greater measure to the country's war program.

Inland Steel Company

By W. SYKES . . .
PRESIDENT

▲ NO more ringing tribute to American industry's initiative and ingenuity will ever be written than that contained in the production figures for war material flowing from our factories in ever swelling streams. Production goals were set that seemed almost ridiculously high, but against such challenging odds as plant conversions, personnel training and materials scarcities, they were met—and exceeded. Each company faced its own particular "unsurmountable" problems—and solved them.

The efforts of Inland Steel Company in meeting the demands of this emergency no doubt typify those of thousands of other American companies, and especially those in the steel industry.

Long before Pearl Harbor, a substantial portion of the steel produced by Inland was going into national defense and, through the lend-lease program, to those countries fighting aggressors all over the world. Since that dark day in December when America was thrown into a struggle for survival, Inland has completely turned its every facility to meet the wartime steel needs of the nation—in fact, all previous blast furnace, open hearth and mill production records have been broken.

This complete shift to wartime production posed many and diverse problems, which for simplicity might be grouped as follows: 1. maintaining a high production rate; 2. meeting changes in production requirements; 3. overcoming shortages of critical materials; 4. expanding production facilities; 5. protecting production facilities; 6. training workers; and, 7. maintaining general morale.

Maintaining A High Production Rate

Maintaining a high production rate has involved eliminating bottlenecks and overcoming other difficulties as they arose. First, shortages in coke have been met by arranging for outside purchase of some of this material. Second, steps have been taken to maintain a high rate of production in the open hearth departments, the capacity of which really measures the production of the Inland mills. Particularly in the open hearths, but also elsewhere in the plant, very careful planning of repairs and general maintenance has permitted the holding of an unusually high average production rate.

One of the greatest difficulties has been obtaining a sufficient quantity of usable scrap for the open hearth furnaces. The declining quality of the scrap has required unusually careful control, and the shortage in scrap has necessitated the use of a higher ratio of pig iron to scrap. Careful planning and the addition of new equipment have made possible the production of a greater quantity of pig. Extensive changes are being made to the No. 1 and No. 2 open hearths to make possible the handling of still higher pig iron to scrap ratio charges.

A great deal of work has been done to meet product changes necessitated by wartime needs. The special steel requirements of the Army Ordnance Department have been very successfully met by Inland. Two outstanding examples are the steel we supply the Ordnance Department for the making of big guns, and more recently the selection of our Hi-Steel for the making of a certain gun carriage.

The trend in products has been away from light sheet steel for the automobile industry to plates for the shipbuilding program, and there has been a drift away from the rolling of rails to the rolling of more structurals. We have done a really outstanding job in increasing our plant production at the plate mill where we installed a new shear with capacity to handle 1½ in. cold plate, including run-out tables, piling pockets, and caster bed. This installation made possible the production of not only a greater tonnage but a greater variety of plate.

We have successfully converted the 76 in. hot strip mill to the rolling of shipbuilding plate. The installation of additional shearing equipment here has enabled us to ship up to 80,000 tons of plate

per month where previously 20,000 tons per month was normal. A real tribute to the ability of our organization is the rolling of wide plate meeting close tolerances and rigid requirements for shipbuilding plate without the necessity of side shearing.

We have been doing much toward overcoming the shortage in critical materials, through both our research program and the installation of new production facilities. The shortage in tin has created a critical situation for the United Nations, because of the necessity of our packaging unusually large quantities of foodstuffs as the food storehouse of the world, while the Japanese have robbed us of our main source of tin.

As you know, the electrolytic process permits the making of tin plate with lighter tin coating than is possible in the hot-dip process; and the newer bonderizing permits the use of black plate after lacquering in the packaging of certain food products. Two electrolytic tinning lines and one bonderizing line have been added in the tin mill department. One line will be in operation in August and the second in December. It is perhaps worth noting here that our research on material for making tin cans used in the packaging of food has resulted in some outstanding attainments that promise even greater contributions for the future.

We have already completed additions in our own plant and also are building, for the Defense Plant Corporation, a new plant on a site immediately adjoining our plant No. 1. This new plant will include two 1200-ton blast furnaces, 146 Kopper's coke ovens with all auxiliary equipment. It is expected that these new facilities will be in operation in February, 1943.

Among the additions to Inland's own facilities are the No. 6 blast furnace, which will be in operation in November and will increase our production of pig iron approximately 1200 tons per day when all furnaces are running. It is anticipated, however, that No. 6 will take the place of another furnace down for necessary relining.

A new sinter plant under construction will increase our present sinter production 160 per cent. A new ore bridge on order will make it possible to handle more ore and to assist in dispatching ore boats. A dry blast system has been installed for use on one of our blast furnaces; it is hoped that this will give closer control of iron quality and reduce coke consumption.

To protect plant facilities, a complete catastrophe organization has been established for the handling of such emergencies as air raids and saboteur explosions, and a more extensive surveillance of the premises has been instituted. As an example of the extensive organization built up for plant protection, approximately 1,000 men have been trained in first aid work.

Maintaining General Morale

The problem of maintaining general morale has been attacked in a variety of ways. It involves employer-employee relations as well as building war consciousness. A joint Victory Production Committee has been organized with some 20 men representing labor and management to handle specific wartime problems. We have suggestion boxes, with a committee organized to review all suggestions received. The splendid safety record of the plant is but one evidence of the intelligent spirit of cooperation which prevails. Since Pearl Harbor, with approximately 16,000,000 man hours of work, the Inland plant has not had a single fatal accident and the rate of injuries per man hour has decreased in spite of the increased operations and the necessity for training men in new jobs.

The calling of men into service, along with the increased demand for workers because of the higher steel production rate, has made the training of employees an important problem at Inland. A complete program has been laid out, with three general types of training: foreman conference, apprenticeship and job training. These three general types of instruction or training procedures are adapted according to the nature of the work for which training is given. The entire program is proving satisfactory in providing the necessary trained men to replace those men called to service and to fill new positions created by the increase in steel production.

Shortage of scrap represents the principal threat to the maintenance of present production. However, with the coming completion of the Defense Plant Corporation blast furnaces, we believe it is reasonable to expect that we may overcome this shortage.

United States Steel Corporation

STEEL'S BID FOR VICTORY

▲ Production lines of United States Steel Corporation plants are supplying war needs of Allies' battle lines. Virtually all of the corporation's all-time record output is going directly or indirectly into the production of things the United Nations need for victory.

Just as timely today as on March 3, 1942, when he wired the message to Chairman Donald M. Nelson of the War Production Board, is President Benjamin F. Fairless' statement that, "Every man and every facility of United States Steel is squarely behind the production program. . . . Armed forces fighting to defend the liberties of the United Nations can count on the production soldiers of United States Steel to back them to the limit until final victory is won."

Month after month, United States Steel plant production records go by the boards — records in the production of steel ingots, records in finished products, records in ore shipments. And on top of this, the corporation's subsidiaries are constructing, at the request of the government and for the account of the government many additional steel making and finishing facilities — to produce more armor plate for ships and tanks, more shell forgings, unloaded shells and

Fighting the "BATTLE of PRODUCTION"

MORE SOLDIERS
PILOTS
MARINES
MEN

Calls for

MORE PLANES
SHIPS
GUNS
SUPPLIES

Production of war materials has been speeded up, doubled and increased beyond peace time's wildest dreams . . . work hours have been lengthened, single working forces increased to two shifts, and in some cases to three shifts, seven days a week.

Machines are being operated many more hours and at a higher speed than ever before . . . several years of wear and depreciation are being crowded into one . . . machines are fighting the "Battle of Production" . . . and are proving themselves masters of the job . . . a tribute to their makers.

Many of these machines producing war materials are air operated and most air operated machines are equipped with Ross Air Control Valves . . . the valves that have been engineered and built to stand up under continuous use and adverse conditions.

Today all of us are in this battle up to our hilts; let's cooperate with each other; because of our more than 16 years of specialized experience in the air control field, permit us to help you get top production out of your air-actuated machines and equipment . . . as true soldiers, let us cooperate with you in fighting this "Battle of Production."

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★ A SIZE AND TYPE FOR EVERY OPERATION ★

bombs, more ships and ore boats. Vast new facilities are also being added with corporation funds.

The corporation's steel fabricating subsidiaries are rendering important services by fabricating and erecting many structures for our armed forces, as well as for industries essential to our war effort.

And not the least important are the by-product coking operations, constituting one-third of the nation's output of by-product tar, ammonium, sulphate, benzol, toluol, and tar acids; and the supplying of cement for wartime industrial structures, buildings at cantonments, airports, naval bases, shipyards, airplane runways, and military highways.

To do the job, United States Steel is converting old mills into new war plants, developing new facilities and techniques to do a better job, and training thousands of employes for war work. Major changes include enlargement, rebuilding and construction of coke ovens, blast furnaces, bessemer converters, open hearth furnaces, soaking pits and cranes; construction of electric furnaces, slabbing mills, plate mills, and forge shops; installing a cold reduction mill and additional equipment at plate and structural mills; installation of forge presses for armor plate; heat-treating equipment, and facilities for producing heavy armor and deck plate, bombs, shells, and shell forgings, and welded steel barges.

Also under way are installation of facilities for producing electrolytically-coated and other tin plate, cold rolled strip, stainless steel wire, sheet mill equipment, cold rolling mill for stainless steel strip; modernization of electric distributing system; installation of additional ore-loading and ingot mold preparation facilities; and of screen and hardware cloth equipment; concentration of wire product manufacturing facilities; construction of commercial warehouses, power plant, cement mill, barges, and cargo vessels; enlargement of shipyard facilities; reopening of, and installation of equipment at ore and coal mines; rehabilitation of coke ovens; and purchases of a blast furnace, a hot rolled tin plate mill, and railroad equipment such as freight cars and locomotives.

Construction work is progressing rapidly on the corporation's expansion program at Homestead, where 12 new 200 ton open hearth furnaces are expected to add 1,700,000 tons of capacity. These furnaces will be supplied with iron from two new blast furnaces built at Edgar Thomson works. The new blast furnaces, among the largest in the world, will each have a yearly capacity of more than 400,000 tons of pig iron. Also being added at Edgar Thomson are two new bessemer converters with an annual capacity of 675,000 tons. To operate these facilities, a 50,000 kw power plant is being installed, doubling the present power output at Braddock.

Two new electric furnaces at Duquesne will have a yearly output of 100,000 tons.

Facilities for expansion of tank armor production in the Pittsburgh district are expected to be completed before the end of this year, costing five million dollars. These will enable the corporation to more than triple its present output of the principal tank hull parts of special armor plate, heat-treated, fabricated, and ready for assembly at the nation's tank arsenals, where emphasis is now on the welded units rather than the older riveted models. Each tank armor set produced by this plant consists of more than 30 individual pieces of pre-fabricated armor plate which, when, assembled at the arsenal, form the main body of the completed tank.

Conversion of this plant, which was operated as a tin mill from 1901, was started in 1940. The expansion program, in addition to plant structures, involves installation of 10 heat-treating furnaces, three plate-quenching tanks, two abrasive plate cleaners, two roller leveler units, 18 cutting machines, 31 softening machines, 31 brake presses, 13 electric overhead traveling cranes, 15 floor-operated cranes, and miscellaneous plate handling equipment.

To attain increased plate capacity, Carnegie-Illinois steel Corporation, United States Steel subsidiary, converted its most modern plant, Irvin Works, from production of light steels to the more urgently required plates. Facilities originally intended to produce light-gauge material were extensively rebuilt and enlarged in only 37 days. The giant 80-inch hot strip mill was converted to handle plates as big as one inch thick and 72 inches wide. The converted plant has been geared to a monthly schedule of 60,000 tons of plates, and this figure will probably climb considerably as the new facilities come into full production. Considerable work has also been done toward increasing plate production of existing mills, and new plate facilities are being installed.

To aid in conserving the nation's vital supply of pig tin, United States Steel subsidiaries are installing nine additional electrolytic tin plating production lines and six supplemental production lines for chemically treating black plate. Electrolytic tin plate is produced by coating black plate with tin by means of electric current passing through a solution, rather that by the conventional dipping of black plate into molten tin. The new plants are to be located in Chicago, Pittsburgh, and Birmingham. The electrolytic lines will have a total annual capacity of approximately 675,000 tons, and will save more than 5000 tons of pig tin a year as compared with the conventional hot dip method of coating black plate. The chemical treatment lines will have a total annual capacity of about 150,000 tons. Most of the chemically-treated black plate will later be lacquered by the can makers and will be used where appropriate in applications formerly served by tin plate. Applied in this manner, the chemically-treated black plate will indirectly effect a saving of nearly 1900 tons of tin a year.

Production of bombs by a revolutionary new spinning method was developed by National Tube Company and is now being used without charge by several other bomb-producing companies. In this process, a pre-heated steel tube, turned at a high rate of speed, is first fashioned into the nose and main body of the bomb, and then is spun to form the tail end. Bombs have lugs welded on, and then are normalized, finished, threaded, painted and shipped to loading plants.

Another war job is National Tube's production at Lorain Works of 24-inch steel pipe for the new 550-mile petroleum line from Texas to Illinois, under a government directive. The pipeline, when completed,

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There are many sound reasons why you should have your cold working rolls remade or rehardened by the "Tool Steel" process—
1. Usually gives much longer life than new rolls.
2. Immediate delivery can be made (no waiting for raw material).
3. Conserves vital steel alloys by re-use.
4. Costs but 25% to 75% of new rolls.
5. Proven-in-service raw material used.
6. Practically all of your cold working rolls are suitable for remaking or rehardening.
Let us show you how your leveller, pinch, coiler, tension, straightening, and work rolls can be made to give you the maximum of service.
THE TOOL STEEL GEAR & PINION COMPANY
CINCINNATI, OHIO

will deliver an estimated 300,000 barrels of oil daily for transhipment to the eastern seaboard, where a steady flow of oil is vital to the war effort. B. F. Harris, National Tube president, emphasized that other vital war production is continuing uninterrupted at an even greater rate of production, and in addition the company is supplying bomb tubing requirements of a large proportion of the firms which are entering the field of bomb production.

Another United States Steel subsidiary, American Bridge Company is manufacturing electric Heroult furnaces, with orders being completed at present for 20 furnaces, representing a rated yearly production capacity of something less than a million tons of high alloy and stainless steels.

A far-reaching program of expansion of steel-making and finishing facilities of Tennessee Coal, Iron and Railroad Company reached virtual completion with the blowing-in of a new blast furnace, increasing TCI's pig iron capacity by 17 percent. The blast furnace is the first with an all-welded outer shell. Included in this program was a new battery of 73 by-product coke ovens, having an annual capacity of about 425,000 net tons of coke. This brings TCI's total coke capacity to 2,330,000 net tons per year. The company's capacity for shell forgings was also increased by the installation of new equipment.

Columbia Steel Company in San Francisco announced additions and improvements which will materially increase production at the company's Pittsburgh and Torrance, Cal., plants. Cost of the expansion program, which provides additional open hearth and electric furnace capacity, and alterations and improvements in finishing departments, is set at eight and one-half million dollars.

Steel castings being produced for Navy vessels are examined by a new one-million-volt X-ray machine recently installed by Columbia. Replacing 400,000-volt X-ray equipment which could penetrate 5½ inches of solid steel, showing up shrinks, cavities, inclusions or other internal defects of two percent magnitude or greater, the new machine will penetrate up to 10½ inches of steel with the same sensitivity.

Flat cars loaded with steel castings for radiographic examination are run into a specially-built laboratory housing the X-ray. Operators work behind a concrete wall 24 inches thick for protection against the X-rays. Latest specifications of the Navy require that certain castings for naval vessels must be radiographed to insure internal soundness, and Columbia Steel is keeping the X-ray lab busy these days.

Additional facilities have been installed for construction of war vessels at the plant of the Federal Shipbuilding and Drydock Company at Kearny, N. J., and for construction of ore-carrying vessels for the corporation's own use.

Record Output

In pushing its facilities to the limit to meet war demands, United States Steel is producing metals in record quantities, and the corporation's subsidiaries are headed for higher levels with the extensive expansion work underway.

In the all-out production drive, men, equipment, and raw materials are being utilized to the utmost to attain the greatest steel tonnage output in the corporation's history. Output figures show an almost endless succession of new production records — records made one month, to be broken the next. New highs, for individual subsidiaries as well as for the entire corporation, have been reached in iron and steel production, in plate production, and in a host of auxiliary departments and units.

United States Steel production this year will surpass the peak year of 1929 by more than 6,000,000 tons; its production of ship plates today is greater than the ship plate capacity of the entire steel industry in 1939; its total steel output now is greater than Germany's.

A shortage of scrap has led to an emergency salvage program Automobile "graveyards" are being canvassed for additional scrap, and open hearth and blast furnace slag piles are being searched for metals that might be used for making war implements. Steel mills of the nation consumed more iron and steel scrap in the first half of 1942 than in all of 1917, the peak year of the first World War, and nearly three times as much as in 1932, bottom year of the depression. Total melt the first half of this year was 27,843,000 gross tons against 26,800,000 tons in the entire year of 1917 and only 10 million tons in all of 1932.

Research activities in the corporation's laboratories have kept apace with the production lines. The tempo of the laboratory worker has been quickened, and from normal endeavor to learn as much as possible of the science of metals, as applied to steel-making and treating, there has been a rapid trend toward developing accurate information about the many items of steel technology which are especially involved in waging war against the enemy. The accent has been placed more sharply upon applied science.

Effective use of precious alloying elements is possible because of a long-time study of the fundamentals involved in several alloy steel systems. Substitutions now can be made with greater assurance of success. Suitable heat treatments for steel intended for special purposes are now quickly developed on the basis of scientific investigations already completed. With increased emphasis on such products as bullet steel, aircraft material, armor plate, and bombs and shell steel, the transition was readily made with the excellent steels heretofore developed for peacetime applications.

Many of United States Steel's technologists are working with government war agencies, in the interest of supplying war needs. The facilities of the laboratories are recurrently at the service of government arsenals and have been used extensively for the development of guiding data.

Extensive research is being done on possible use of light-gauge low-alloy steel sheets in building planes. This steel product would be of somewhat higher grade than the ordinary black plate used in making tin, but some of the corporation's steel plants might be adapted to its manufacture if experiments are successful enough to justify large-scale production. In this program, use of steel instead of aluminum

In Steel Gears and Castings

(NE) . . . is maintaining the leadership in war-time Service of Supply which it achieved in serving a peace time Industrial Nation with Neloy and Neloy Molybdenum Steel Gears and Castings. War-time production comes first on any schedule . . . however, sufficient capacity in plant and equipment is available for producing maintenance parts important to the smooth running of Industry's heavy schedules today . . . the National Erie Corporation producing to specifications for Uncle Sam, stands ready to do its utmost to supply necessary maintenance parts for heavy machinery... Iron and Steel Engineers can depend upon our earnest efforts to serve them as promptly as possible for the Duration.

NATIONAL-ERIE
CORPORATION
ERIE, (NE) PA., U.S.A.

sheets for the "skin" of airplanes is being developed, permitting spotwelding, eliminating rivets which add wind resistance and weight, and speeding up production time and cutting costs.

One of Carnegie-Illinois's big achievements is the production of portable steel runways for planes, hailed by aviation experts as one of the outstanding developments in aviation since the start of the war. Developed by a Pittsburgh sales representative of the corporation, G. G. Greulich, the portable landing field is made up of many perforated rectangular sections, 10 feet long and 15 inches wide. These are specially pre-fabricated to facilitate assembly. Stamping of a triple row of holes out of each section lightens the weight of the material for rapid handling and affords a remarkable degree of natural camouflage in permitting grass to grow above the surface. These rapidly-assembled air fields of steel greatly increase the combat effectiveness of our fighting airmen in remote strategic points where the terrain limits regular air field facilities.

Training Progress

To meet pressing war-time labor requirements and to provide personnel replacements as a result of America's participation in the war, thousands of employees of United States Steel subsidiaries are undergoing intensive training for skilled jobs. The training program is being cordinated at all points with national objectives, and has contributed materially to the increased output of steel and other products vital to the war effort. Training of workers for industry is apace with the military training of the nation's combat forces. The pressure for increased production resulted in adding to the working forces many new employees who had to be trained for the work they were to do. In addition to this job-training program, the corporation's subsidiaries have long-range apprenticeship courses from which a considerable number of employees are graduated annually.

The employee upgrading and training program of Carnegie-Illinois has been described as a model for other industries, in a bulletin of the Labor Division of the War Production Board.

In accordance with the official plan as outlined by WPB chairman Donald M. Nelson, subsidiary companies have set up joint management-labor production drive committees. The committees are meeting regularly and are functioning in the development of new methods and the speeding up of production.

Accident prevention in industry is primarily to protect life and limb, but a second objective during war time is to prevent production delays caused by mishaps. The thousands of new workers added to the corporation's personnel since the outbreak of war placed a new burden on safety training. Visual education has been widely developed through the use of sound-slide projection methods, showing pictures of unsafe practices with supplementary pictures of the correct way to perform such practices. This plan is a far cry from that of former days when safety meeting were convened in the foremen's office. Also widely developed is the use of unusual posters which emphasize the need for safety. Drawings of professional cartoonists and amateurs are displayed on plant bulletin boards as part of the program to get safety messages across to the workers.

Expenditures of United States Steel chargeable to accident prevention and related items in 1941 totaled $6,400,000, and the record for the year represented a notable improvement over 1940, despite the higher rate of operations and the greater number of employees engaged.

Despite the record output of its subsidiaries, United States Steel recognizes the need for still greater production and is aiming toward that end. Increased output will result from many new facilities nearing completion, but this answers only one phase of the problem. A greater flow of raw materials is needed, and improved methods of training new employees, intensified safety instruction, speed-up in equipment repairs, elimination of "bottlenecks" that slow up performance, standardization of specifications, faster delivery of essential materials and equipment — these and many other factors will help boost the production rate. Simplification of finished products have far-reaching effects in speeding up output.

The problem of increasing production has wide ramifications. It calls for and benefits from the study and ingenuity of all departments, and of all officials and employees of the company, and in the case of United States Steel output profits by close cooperation between different subsidiaries. Workmen, operating facilities, and research laboratories are closely geared to all-out war production, and the records that are being smashed daily are a tribute to the corporation's "production soldiers", who have enlisted for the duration. The corporation is turning out in ever-increasing quantities the implements of war so urgently needed to insure victory for the Allies, and its contribution to war production is a major one.

Wheeling Steel Corporation

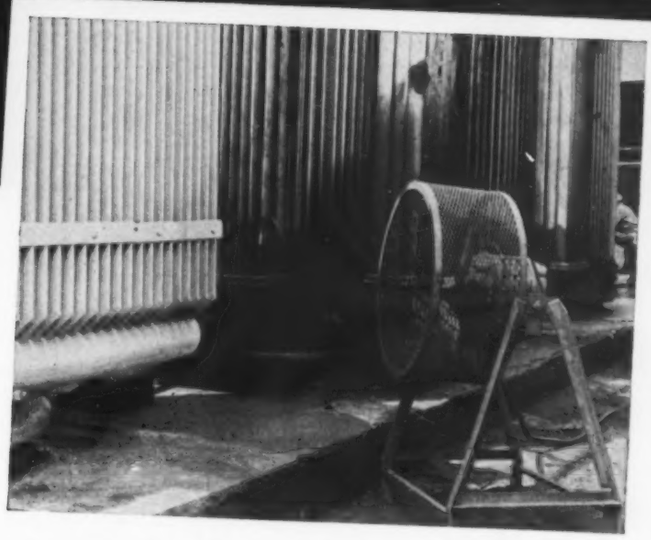
By H. D. Scott
VICE-PRESIDENT

▲ THE Wheeling Steel Corporation, with main offices at Wheeling, West Virginia, and ten producing plants in the Ohio River valley, has, in the intervening months since Pearl Harbor channelled its steel production from combined civilian and military use to the practically exclusive use of the military, ranging from lend-lease semi-finished to bombs, flares and other war time products as directed or indicated by the War Production Board. Starting with iron ore and bituminous coal mines, thence through the blast furnaces and by-product coke plants to basic open hearth and bessemer converters, the translation of steel into the sinews of war has progressed with uninterrupted momentum, the twin objectives of (1)

Let Truflo Fans . . .

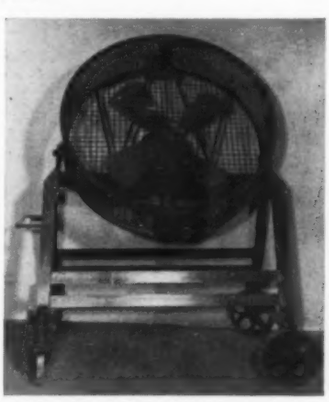
Help keep your workmen on their toes

Portable Fan No. TF-100, recognized as standard in many of the country's largest mills. Sizes from 12 in. to 36 in. in diameter.



Portable Fan No. TF-300 in operation, cooling large transformers in strip mill.

Crane Cab Fan, for cooling crane cab interiors and other confined areas. Available in 12 in. and 18 in. sizes, adjustable both horizontally and vertically.



Portable Fan No. TF-300W. Angle iron support adjusts for vertical or horizontal discharge through almost 360°.

It's more important now than ever before to keep your workmen comfortable. For comfortable workmen are more efficient, produce more work in a given time.

Truflo Fans can help you keep your workmen on their toes. All Truflo Fans are designed and built correctly for efficient, economical operation — they move more air per dollar. Write for free literature on any of the following styles:

Portable Cooling Fans • Crane Cab Fans
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maximum production from available facilities and raw materials in the shortest interval of time and (2) a training policy which provides the necessary manpower when needed, making the execution and continuity of the War Production Board's plans possible.

As an aid to maximum production, the corporation on March 17th signed a "memorandum of understanding" with the Steel Workers organizing Committee (now United Steelworkers of America) setting up joint production drive committees, the expressed purpose of which is to acquire the best possible utilization of men, materials, machines and equipment in the war effort. The organizational outline is as follows:

A. A general production drive committee consisting of two members, one representing the corporation and one representing the union.
B. Ten plant production drive committees (one in each operating unit) consisting likewise of two members, one representing management and one representing the union.
C. Seventy-two departmental drive committees, one for each major operating department in the corporation. These again to consist of two members, one management and one union.

Policy is determined by the general production drive committee which is in constant touch with war production drive headquarters in Washington, down through the plant committees to the operating departmental committees where such devices as bulletin boards, suggestion boxes, production charts, etc., are used to stimulate maximum production. Similarly, productive drive reports originate in the departments' are condensed and summarized by the plant committees and passed on to the general production drive committee, which, from time to time, reports progress to the War Production Board in Washington.

It may be of interest to note that only two rules govern procedure under the framework of the general agreement:

1. The two members shall proceed together and by mutual agreement.
2. Consistent with belief that to win the war will require sacrifice and unselfish service by all, it is agreed the amount of time devoted to production drive committee work shall be determined by voluntary action of each production drive committee, shall be without compensation, and shall be over and above the normal hours of work in connection with the members' regular employment.

The response from this management-labor production drive has been enthusiastic as evidenced by (1) the number of individual suggestions received which varies from one suggestion per 100 employees per month in one plant to ten suggestions per 100 employees per month in another, (2) the willingness of employees to be transferred from one department to another or from one plant to some other as the quantity and character of the work changes with available raw materials (such as zinc and tin) and the requirements of the War Production Board, and (3) the establishment of new production records, the reduction of lost time and the more effective use of the tools of industry.

With a rated annual ingot capacity of 1,960,000 net tons, we are producing (based on the first six months of 1942) ingots at the rate of 1,933,000 tons annually; this in spite of a constantly deteriorating quality of scrap received in our scrap yards. Using above rated capacity figures, the rates of operation for the first six months of 1942 are as follows:

	Per cent
January	101.43
February	91.44
March	103.71
April	99.55
May	99.87
June	95.92
First 6 months average	98.66

While numerous production records have been established on a turn or a day basis, they are relatively meaningless unless maintained over a fairly representative period of time. The following are a number of new monthly all-time high records made this year:

16,686 tons of rods produced on rod mill in month of April.

31,064 tons of bessemer steel produced in April.

10,460 tons of tubes produced on continuous mill in month of June.

76,649 base boxes of terne plate (Yorkville plant) produced in month of March.

3,148 tons of welded wire fabric produced in the month of April.

7,897,000 prints of litho-coated plate produced in month of March.

In addition new all time records were made in less important products such as steel drums, lead annealed wire, straight and cut wire, bale ties, couplings, etc., all of which are standard products which have been made by Wheeling Steel for many years. As to the numerous items of war material, such as gasoline cans, gas tanks for army trucks, bomb rings, parachute flares, etc., new production records are being established each month in one or more items.

Increased productivity of plant capacity has been materially aided through reduction in lost time caused by delays, break-downs and faulty scheduling and in the number and extent of "bottle-necks" on assembly and production lines. These known sources of loss continue to receive careful study by the industrial engineers who are charged with the responsibility of reporting the condition to management with suggestions for their elimination.

Lost time accidents have been reduced by 8 per cent in the first six months of 1942 as compared with the year previous. Intensive work along this line by the safety organization as well as the endeavors of the war production drive committee should further reduce this loss in manpower and production.

Equally important with present high production is he necessity for long range planning in order that manpower will be available to maintain this production. Realizing that the requirements of the War Production Board would cause employment dislocations as between departments and plants of the corporation, Wheeling Steel and the S. W. O. C. on March 17, 1942, jointly signed a "memorandum of

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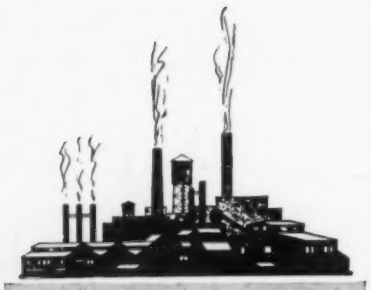
ROLLS
ROLLING MILL EQUIPMENT
SPECIAL MACHINERY

OUR DUAL OBJECTIVE
...in Wartime Service to the Steel Industry



WORTHINGTON EQUIPMENT for STEEL PLANTS

FOR CONTINUOUS STRIP MILLS
Complete descaling systems from pump to spray nozzle.

FOR DRY BLAST SYSTEMS
Dehumidification equipment . . . including centrifugal and reciprocating refrigeration compressors.

FOR BY-PRODUCT COKE PLANTS
General hydraulic service and water supply . . . pumps of every size and type, centrifugal, steam and power.

FOR THE POWER PLANT
Steam turbines, steam condensers, boiler feed pumps, feedwater heaters, air ejectors, vacuum pumps, water softeners and pressure filters.

FOR GENERAL AND LOCAL COMPRESSED AIR SUPPLY
Compressors of every type from the smallest to the largest . . . for every type of drive.

MI2-28

WORTHINGTON products are not built to serve for this period of emergency only. They must continue to operate for many years after the steel industry returns to peace-time production. Therefore there can be no letting down of the rigid standards that have been set for these products as a basic Worthington principle.

It is our aim that Worthington equipment, produced during this difficult period, shall accomplish two purposes . . . first that it shall serve effectively, and without interruption, on the important jobs which it fills . . . and second that, in so doing, it shall make new friends, and retain the confidence of old friends, among the nation's steel producers and fabricators.

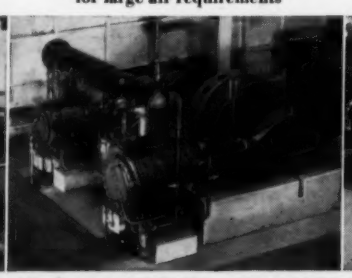
To those plants where Worthington equipment is now in use, we offer the services of our district office engineers, and our headquarters staff, in checking conditions and performance, with a view to assuring continued operation at top efficiency.

And in the planning of readjustment or expansion, whether for the war production program or the period to follow, the counsel of these specially qualified engineers is always available.

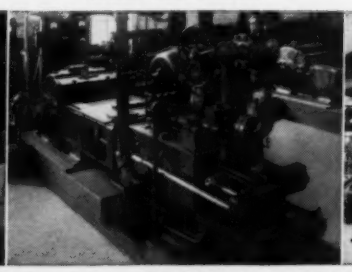
WORTHINGTON

Centrifugal high-pressure pump for descaling service

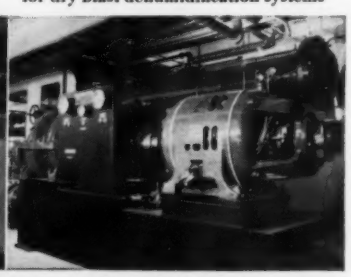
Horizontal duplex compressor for large air requirements



High-pressure pump with synchronized suction valve unloader



Centrifugal refrigeration compressor for dry blast dehumidification systems



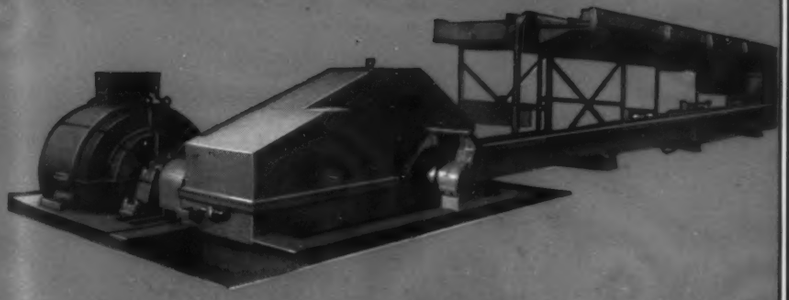
WORTHINGTON PUMP & MACHINERY CORPORATION • GENERAL OFFICES: HARRISON, N. J.

SYMBOLS OF FREEDOM

This isn't just a stone . . .

Plymouth Rock is a memorial to brave men and women who willingly faced danger and privation that they might gain personal liberty.

Now with the world-wide threat of oppression and the conquered nations suffering unspeakable abuses, America is the hope of freedom-loving people everywhere to preserve those ideals for which the pilgrims fought and died.



At a time when manpower is so vital, Aetna Drawbenches, operated by *one man*, are doing an amazing job in turning out cold drawn bars, tubes and rods for our war effort.

The AETNA-STANDARD ENGINEERING COMPANY

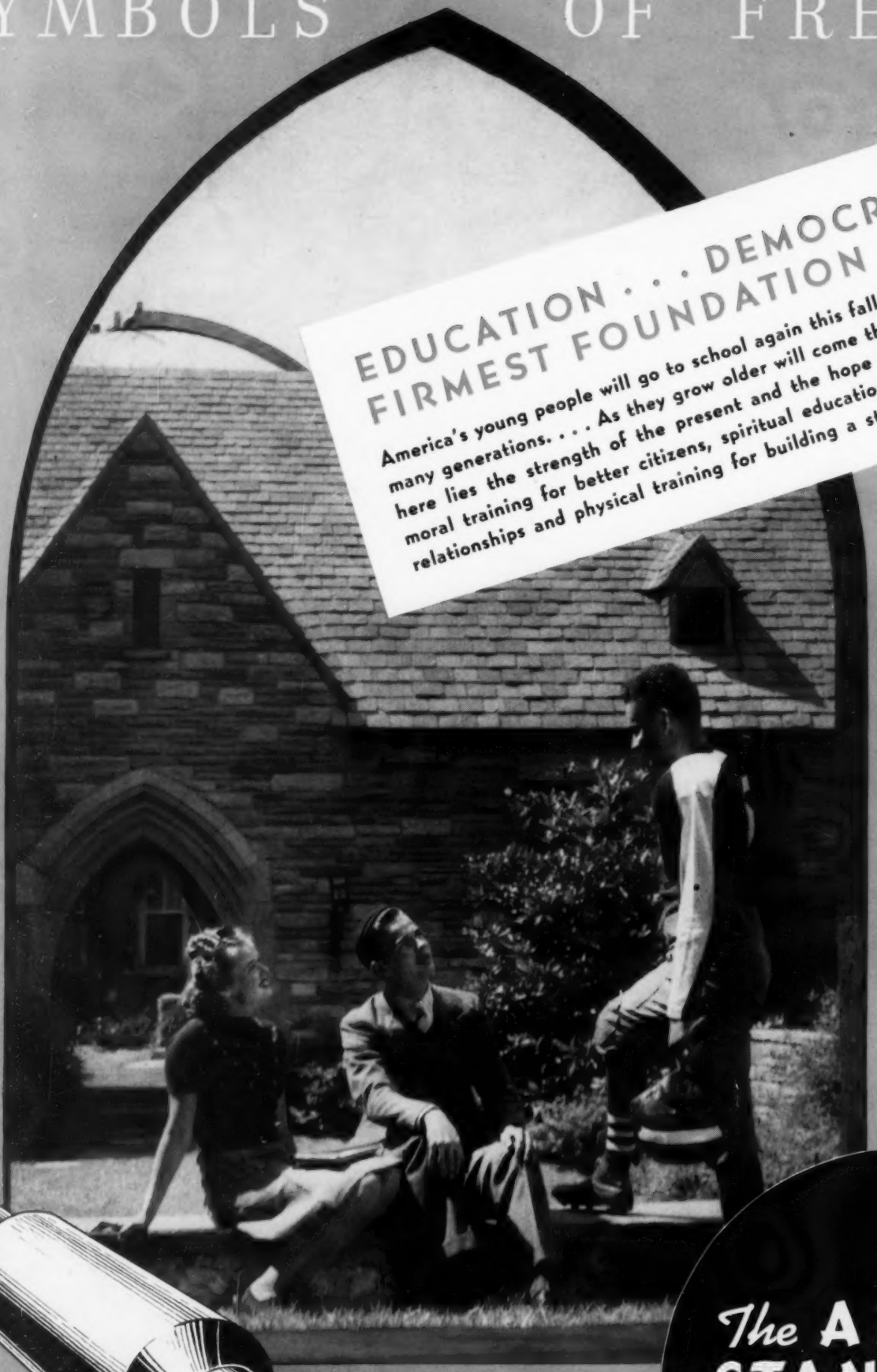
★ YOUNGSTOWN, OHIO, U.S.A. ★

ASSOCIATED COMPANIES

HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND • JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

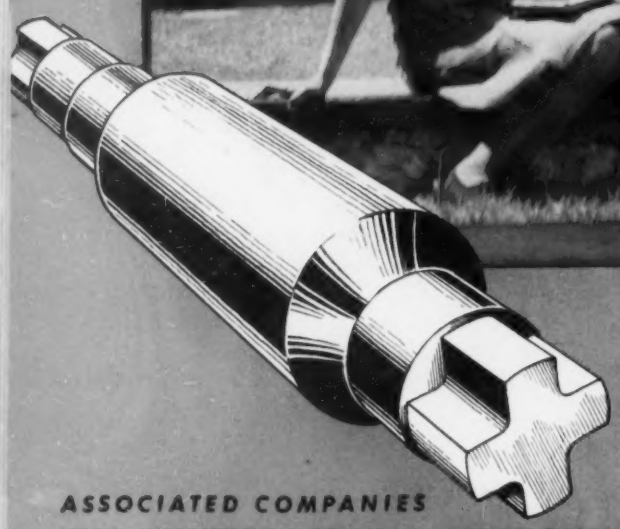
Designers and Builders to the Steel, Non-ferrous and Chemical Industries

SYMBOLS OF FREEDOM



EDUCATION . . . DEMOCRACY'S FIRMEST FOUNDATION . . . .

America's young people will go to school again this fall as they have for many generations. . . . As they grow older will come the realization that here lies the strength of the present and the hope of the future . . . moral training for better citizens, spiritual education for better human relationships and physical training for building a stronger nation.



The war effort of the United Nations vitally depends upon Steel and many of America's leading steel producers depend upon Aetna Rolls.

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understanding" regarding inter-plant transfers and temporary employment as follows:

"Wheeling Steel Corporation and the Steel Workers Organizing Committee recognize a necessity to obtain the maximum possible productive endeavor of the corporation's present employed and reserve labor forces, a necessity not only in the interest of the corporation and its employees but of incomparable importance to the national welfare during the present war emergency.

This emergency requires full utilization of present employed and reserve labor forces (on the basis of availability, qualifications and ability to do the work) before engaging new workers. As an aid to this end, it is mutually agreed as follows:

1. The understandings contained herein originate under the terms of the 1941 agreement between Wheeling Steel Corporation and the Steel Workers Organizing Committee and shall in no way alter the terms, conditions, rights or responsibilities prescribed therein.
2. In the exercise of its management function under the 1941 agreement, the corporation will direct its effort toward full utilization of present employed and reserve labor forces (on the basis of availability, qualifications and ability to do the work) before engaging new workers, by using the practice of inter-plant transfer and temporary employment when it is practicable to do so.
3. In the exercise of its representation function under the 1941 agreement, the Steel Workers Organizing Committee will direct its effort toward full utilization of present employed and reserve labor forces by urging its members who are employees or reserve labor individuals of the corporation to voluntarily accept inter-plant transfer and temporary employment when it is practicable to do so.
4. Under the terms of the 1941 agreement, an employee has seniority or labor reserve standing in but one mill or factory where he or she normally works. Consistent with this agreement provision, and to encourage the practice of inter-plant transfer and temporary employment, it is agreed:
   (a) An employee or labor reserve individual who voluntarily accepts inter-plant transfer and temporary employment (in another mill or factory of the corporation) at the request of the corporation will receive a leave of absence stating to accept inter-plant transfer and temporary employment due to war emergency.
   (b) Upon satisfactory completion of the temporary employment the employee or labor reserve individual will receive a termination stating "satisfactory completion of temporary employment due to war emergency", and shall be returned to the status he or she would normally hold had such inter-plant transfer and temporary employment not been accepted.
   (c) An employee or labor reserve individual who is restored to his or her former status in accordance with paragraph (b) shall be restored without loss of seniority.
5. These understandings concerning inter-plant transfer and temporary employment are for the duration of the war emergency period only."

Training in all its branches has been given consideration from three angles, as follows:

1. Supervisory training — Due to the emergency, there is a pressing need for new supervisors who must be trained) and the supervisory group (as a whole is confronted with the problem of training new employees and the training of old employees for new jobs.

   In order to aid in the upgrading of all supervisors and to prepare the new supervisors we are placing more emphasis on our superintendent's meetings (directed by plant managers) and foremen meetings (directed by department heads). These meetings might be well termed conference groups. We have found it helpful to include more discussions on industrial relation problems along with the discussion of normal production and operating problems.

   In order to prepare our entire supervisory group to properly handle the employee training program we have sent representatives from each plant to "Job Instructor Training Institutes" put on by the War Production Board. Upon the completion of the institute, these men will give J.I.T. courses to our entire supervisory group.

   Many of our supervisors have taken engineering defense courses, particularly in the field of management engineering. The results from these courses have been very gratifying.
2. Employee training — In this day and age every supervisor is a part of a training program due to the necessity of upgrading to take care of employee losses due to a variety of reasons.

   The good effects of job instructor training are felt in every department.

   Especially in new departments we are using the industrial engineering department to study jobs in order that the employee may receive better "on-the-job" training.

   We have used very effectively and wherever possible supplementary and pre-employment refresher courses given by the various governmental agencies.
3. Apprentice training — In our apprentice training program we have made every effort to maintain our standards so that the graduates will be really "all-round" journeymen.

   In order to accomplish this we are attempting at all times to improve the quality of the related instruction and to improve the quality of our new apprentices. With the emphasis on training in production departments, we have found a corresponding increase in interest and effort by the people who are instructing apprentices in their work processes.

With the advent of war and the necessity of increased plant protection, the corporation inaugurated a comprehensive method of identification with personal history cards, proof of citizenship, fingerprint-

ing and visual identification badges. This now serves the useful purpose of faciliating transfers to restricted areas, from which aliens are barred, and where articles of military secrecy are being produced.

Men and management of Wheeling Steel Corporation have earnestly endeavored to come to grips with problems as they arise, and to foresee, insofar as is possible, future needs and requirements in order that the war effort may be implemented with all the brains and manpower in possession of the Wheeling family.

Bethlehem Steel Company

▲ AFTER the first World War German leaders said that the major factor in their defeat was the tremendous American munition production supplying the allied armies.

At that time Bethlehem produced approximately 60 per cent of the finished guns, 65 per cent of the gun forgings and 40 per cent of the complete artillery ammunition made in this country.

Bethlehem now has five times the steel-making capacity that it had in World War I. Furthermore, America's involvement in the war found this organization far advanced on programs to gear this steel-making capacity to the nation's requirements for armament specialties.

Aware of the increasing menace to this country in the spreading of the war since early in 1940, Bethlehem management bent every effort to place this organization's productive power behind the American rearmament program and the national policy of supplying all possible material aid to the nations fighting aggression.

As a result of steps taken more than a year ago, facilities that more than double Bethlehem's already large capacity for heavy forged products for the Navy are now coming into play. Gun forgings, armor, shells, ship shafting and torpedo forgings are being turned out at an ever increasing rate.

Equipment for making cylinders and other forged parts for airplane motors has kept up with the successively stepped-up airplane production programs.

Capacity for electric-furnace steels has been increased more than four times and capacity for high grade alloy steels has been greatly expanded by extension of facilities for billet preparation.

Five new open hearth furnaces, completed during 1941, increased Bethlehem's open-hearth steel capacity by 850,000 tons annually to a total of 12,700,000 tons. Two new blast furnaces completed, with two rebuilt and enlarged, support the expanded steel-making operations. Two new batteries of coke ovens to supply the coke for the stepped-up blast furnace operations, were completed last year.

Work is now being rushed on an additional expansion program including three blast furnaces, three batteries of coke ovens and an open hearth furnace. These facilities will add substantially to Bethlehem's steel-making capacity and offset the scrap shortgae. Finishing equipment now being installed will greatly increase capacity for plates.

In addition to these major steps to meet the needs of the times a great variety of lesser installations have been made to adapt Bethlehem operations to the requirements of the armament program. These include such diverse items as shell and bomb manufacturing equipment, wire drawing blocks, heat-treating facilities and coke oven by-product equipment to make toluol for explosives.

Money spent and earmarked to be spent by Bethlehem from the beginning of World War II to the end of 1941 for facilities contributing directly and indirectly to this country's war potential is in excess of $127,000,000.

In addition to the increased capacity for war materials provided by Bethlehem's expenditures, additional facilities costing approximately $222,000,000 have been or are being built at the steel and shipbuilding plants for the U. S. Government, to be operated by Bethlehem.

A total of 45 ships slid down the ways in Bethlehem shipyards during 1941. It is expected that this year launchings will average about two per week.

A great expansion of shipbuilding facilities was carried out during the year. This included the building of new ways and the reconditioning of old ones, the extension of fabricating and machine shops, the installation of numerous new machine tools and the purchase of a great amount of cutting, burning and welding equipment and tools for general yard use.

During 1941 a new shipyard was brought into full operation to build "Liberty Fleet" cargo vessels. The first of an order for 62 vessels was launched on September 29th. A total of seven ships were launched at this yard before the close of 1941. Shortly after the first of the year orders for 182 more ships were received from the U. S. Navy and the Maritime Commission.

The Shipbuilding Division has undertaken to construct two additional mass production yards this year to handle a large share of the country's wartime shipbuilding. With shipping the key to the application of America's war effort, the operations of Bethlehem's ship repair yards are an important part of the company's contribution to the country's war needs.

Republic Steel Corporation

By R. J. WYSOR

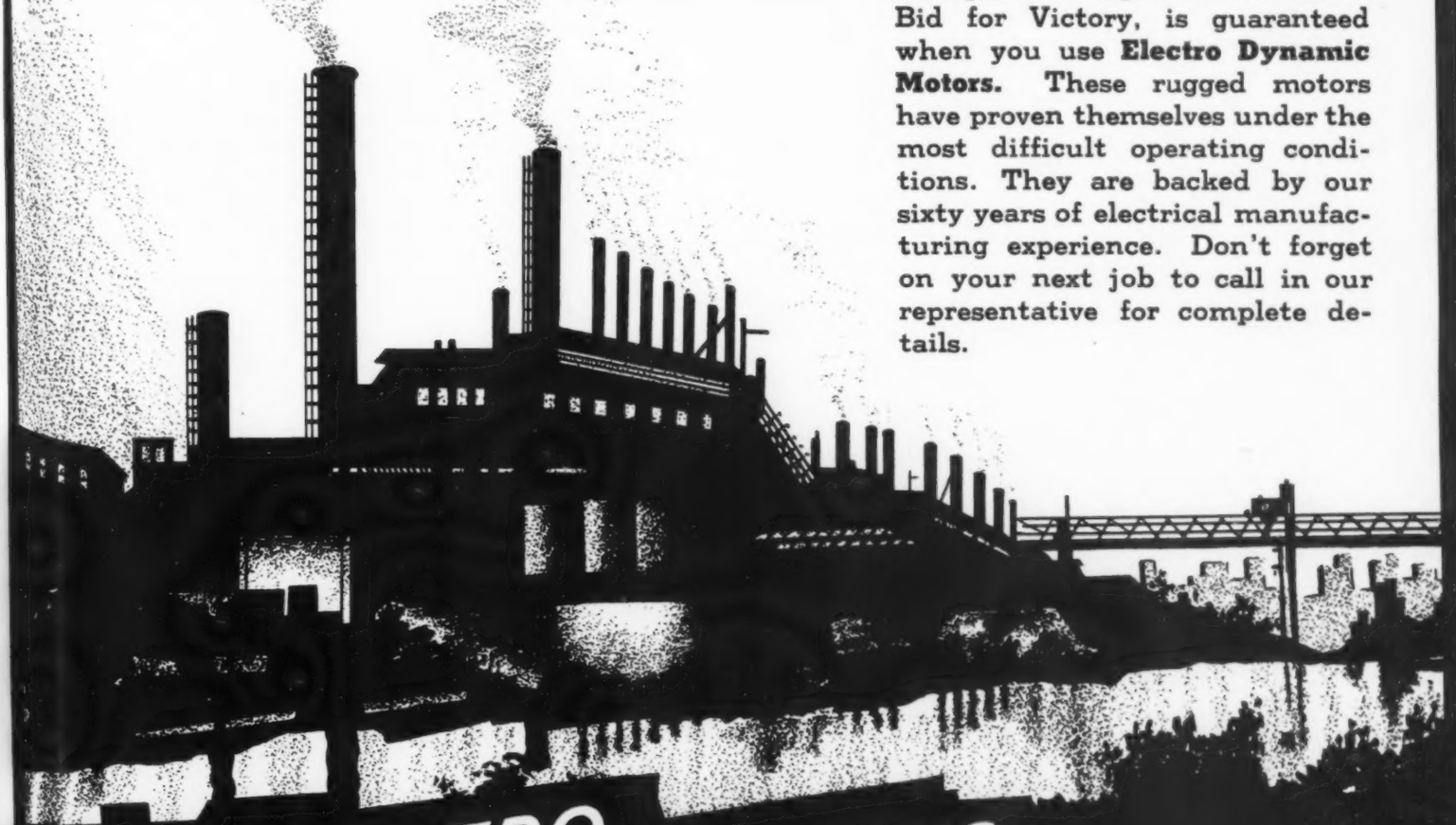
PRESIDENT

▲ THE expansion program of Republic Steel Corporation began many months before December 7th,

PRODUCTION in STEEL

is the watch-word today

Continuous production in your steel plant, being so vital to Steel's Bid for Victory, is guaranteed when you use Electro Dynamic Motors. These rugged motors have proven themselves under the most difficult operating conditions. They are backed by our sixty years of electrical manufacturing experience. Don't forget on your next job to call in our representative for complete details.



ELECTRO DYNAMIC WORKS

OF THE ELECTRIC BOAT COMPANY — BAYONNE, N. J.

PITTSBURGH OFFICE — 1007 INVESTMENT BUILDING

in fact more than a year before the United States entered World War II as an active combatant. It was before the first shots were fired by Germany in Poland—September, 1939—that Republic anticipated future war needs.

At that time Republic's management foresaw a potentially serious shortage of electric furnace steel. To meet this potential shortage, Republic financed a substantial expansion to its electric furnace capacity. It was entirely appropriate that Republic should take this step because not only was it the largest producer of this type of steel in the country, but through some of its predecessor companies it had a long history and tradition in the production of this essential steel.

Utilized substantially in the manufacture of airplanes and automobiles of all types—particularly aviation motors—of armor plate, of critical parts in trucks, jeeps and other combat vehicles and in countless other places in our war production program, a bottle neck in electric furnace steel would have resulted in a serious handicap to the fighting forces of the United Nations.

As a result of the expansion program decided upon nearly three years ago, Republic's output of electric furnace steel is several hundred percent greater than it was in the fall of 1939 and the much feared bottle neck has not yet evidenced itself.

As has already been indicated, an important use of electric furnace steel is in the manufacture of light armor plate. Again as a result of a fortunate circumstance, Republic had been experimenting with light armor plate virtually since the formation of the corporation. When the demand arose therefore for tanks, the company was able to quickly step into the picture and produce plate without going through a long period of experiments and research. Since then, tanks armored with Republic products have seen service in Libya and on many other far-flung battle fields.

Republic has also had an important part in bringing a partial solution to the very serious problem of steel scrap shortages. Two methods were adopted. One was the construction by the government at Republic properties of additional blast furnaces. The other was the "mining" of decades-old slag dumps.

In the first case plans were made for the construction of four blast furnaces and immediate steps taken toward their engineering. As a result, the first furnace in this program was completed some five weeks ahead of schedule. It was designed by Republic engineers and its construction was supervised by the company's engineering staff. The second furnace will be near completion by the time this article appears in print and will be followed at short intervals by the other two.

The company's "slag mining" operations have been unique. Probably the first company to undertake this project on a large scale, it began more than a year ago on a program of recovering steel from open hearth slag dumps. To date nearly a dozen dumps have been worked, some of them 40 years old. Out of these dumps have come many thousands of tons of metal, some of it containing a sufficiently high percentage of nickel and other alloys to be of substantial benefit during this period of alloy shortage. These "mining" operations have been a real help to Republic in these times of scrap scarcity.

A third important project to meet a definite and vital war need was the expansion of the company's plate capacity. This expansion took place in two of its plants and has resulted in a ship plate production far beyond the estimates originally set. Until two years ago Republic's record plate shipments for any one month amounted to slightly over 20,000 tons. Currently, production is several times this record tonnage. This production was reached by transforming sheet and strip capacity to plate cappacity together with the installation of additional equipment needed to produce plate but not required for sheet or strip.

Existing facilities are constantly being expanded and new facilities installed to meet war requirements as they arise from month to month. Under construction at present, for instance, are plants for the production of large gun bloom forgings and for rough turned and bored gun forgings.

At its mines the company has developed methods for ore concentration which are definitely more economical and superior to those used previously.

In addition to these major contributions, Republic has developed a method for making rifle and machine gun barrel blanks which reduces the time required for machine work in finishing the blanks.

It has also perfected a process for electric welding alloy steel aircraft tubing, which is of definite value to the all-important aviation industry.

The manufacturing divisions of the corporation are making war contributions as important in their field as are the steel producing divisions.

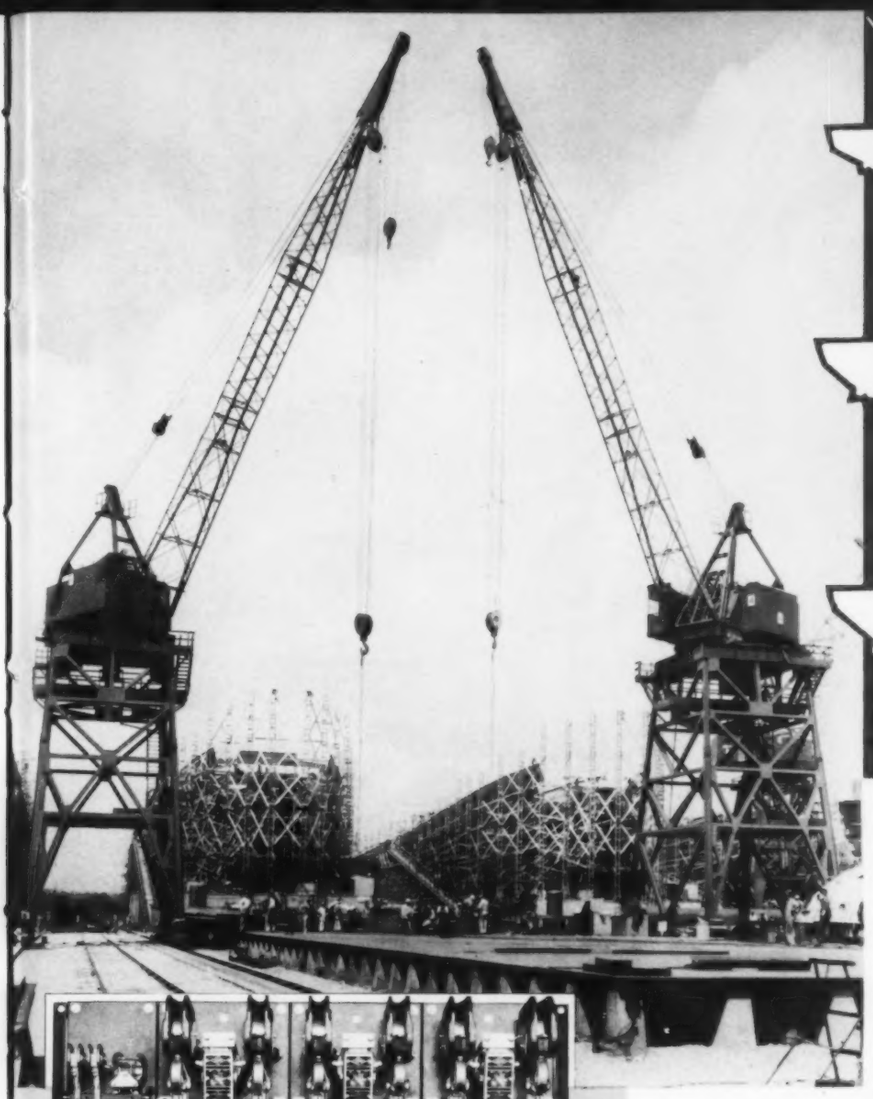
The obvious problem in the cases of the manufacturing plants was that of transforming their productive capacity from peace to war materials. In many cases this necessitated re-equipping in substantial part and a training of many employees.

Prior to the war, these plants turned out automobile and refrigerator parts, building materials, lockers, shelving, metal furniture, standard buildings, industrial and residential sash, and scores of other highly diversified products. These plants are now producing assemblies for tanks, trucks, mobile gun carriages, aircraft, bomb fuses, ammunition magazines and boxes, enormous airplane hangar doors, airport landing mats, metal tank treads, pre-fabricated sections of barges, airplane fuselage assemblies and many other war time necessities.

Important as are the facilities and plants, the spirit and cooperation of the employees are essential to any successful war production program. Indicative of the spirit of Republic men and women is the fact that of 170 major producing departments in the steel plants and mines 123 have broken all monthly production records at least once since December, 1940.

Many departments have established new records one month only to break them the next.

During the past 19 months these departments have established 421 monthly production records.



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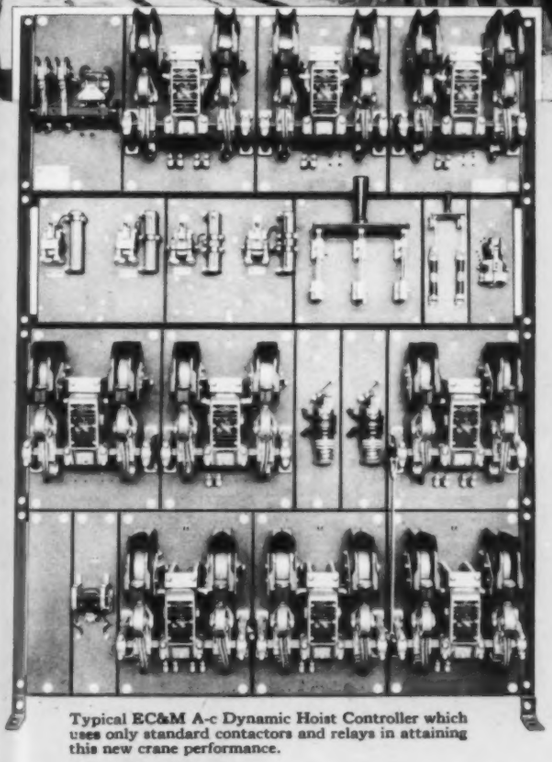


Typical EC&M A-c Dynamic Hoist Controller which uses only standard contactors and relays in attaining this new crane performance.

★ Now . . . it is *being done* with *all A-c* Control. No mechanical load-brakes . . . no conversion units. Instead, only a simple controller to operate a standard A-c wound-rotor, crane-hoist motor. The *EC&M A-c Dynamic Lowering Hoist Controller* is used on the main hoists of these Clyde Whirley 45-Ton cranes in this shipyard.

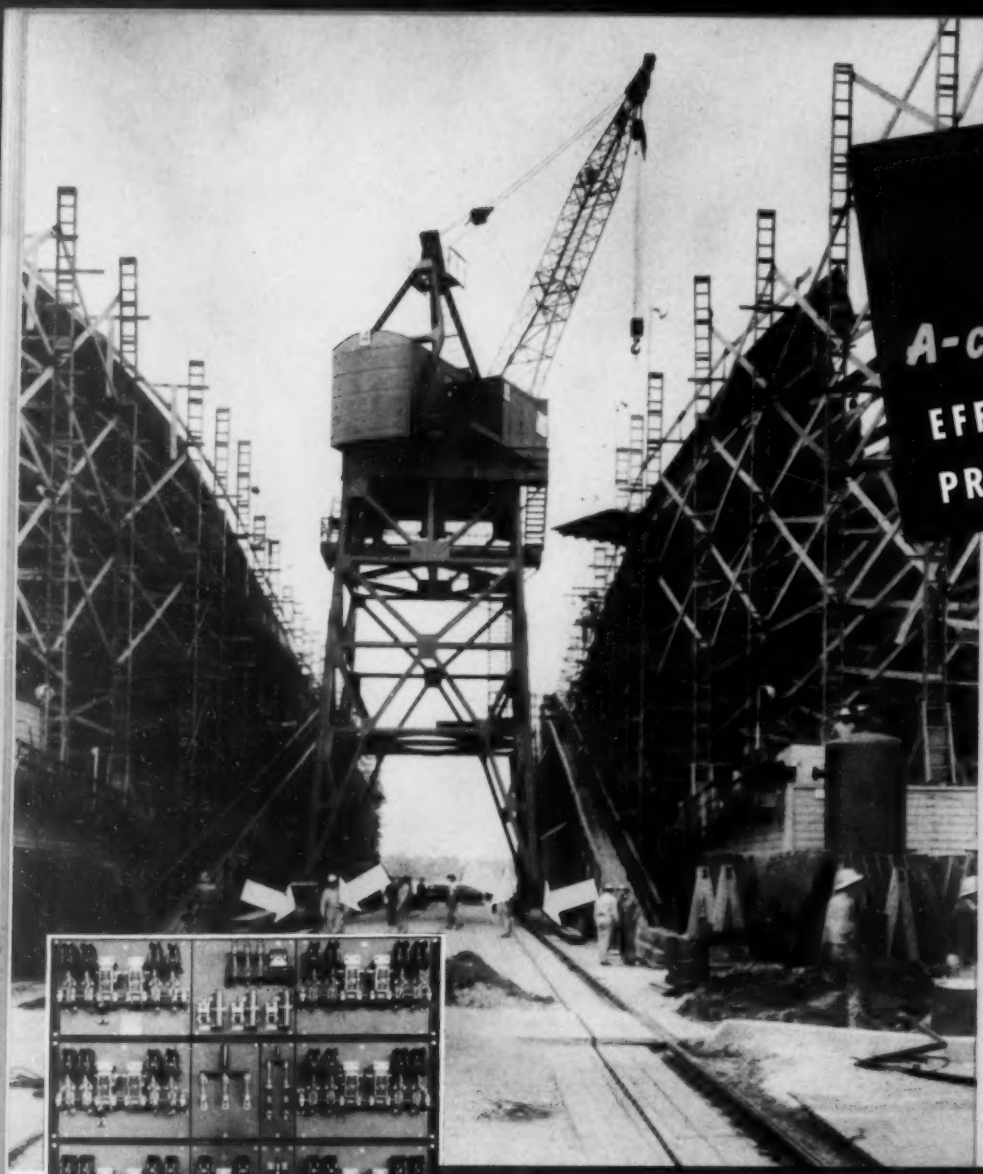
Prefabricated bulkheads, double-bottoms, machinery, such as 40-ton engine-bases, and other heavy parts to be incorporated in the ships are delivered on split-second schedule and *accurately spotted* in position by this new EC&M A-c Hoist Control. When working together, both cranes handle as much as a 72-ton mid-ship deckhouse. Booklet 930 shows other precision-handling jobs now possible with EC&M All A-c Control. Write for copy today.

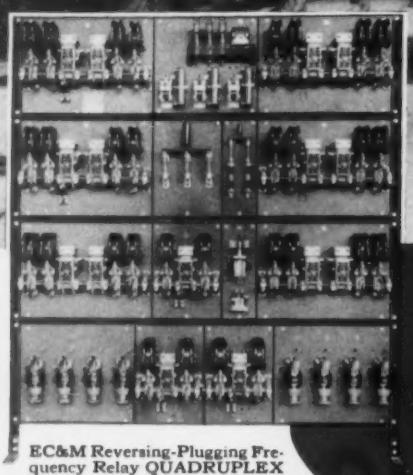
THE ELECTRIC CONTROLLER & MFG. CO.
CLEVELAND OHIO

Frequency Relay AC Crane Control

EC&M

A-c QUADRUPLEX CONTROL EFFICIENTLY GOVERNS 4-MOTOR PROPELLING DRIVE ON THIS CRANE





EC&M Reversing-Plugging Frequency Relay QUADRUPLEX Magnetic Controller for simultaneous operation of 4-10 HP, 440 volt motors on bridge motion of this shipway crane.

The whirler crane here shown is operated by four motors, one on each leg. The part which the control plays is vitally important. It must insure equal division of the motor load or else there is danger of severe strains on machinery or damage to the motors.

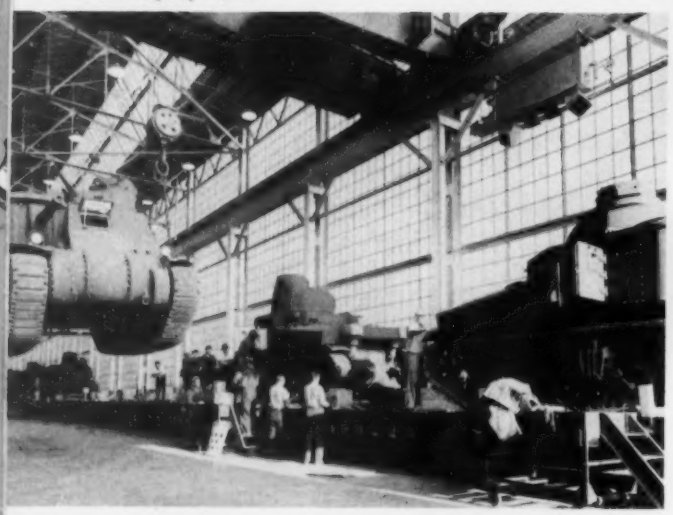
EC&M Quadruplex Frequency Relay Controllers have been built to meet the requirements of these 4-motor bridge drives. Under automatic control of EC&M Frequency Relays, these controllers provide smooth operation of all motors during starting, acceleration, plugging and stopping, causing them to operate as smoothly as a single motor drive.

For cranes using only 2 motors on the bridge motion, similar control, but of the EC&M Duplex type, is supplied.

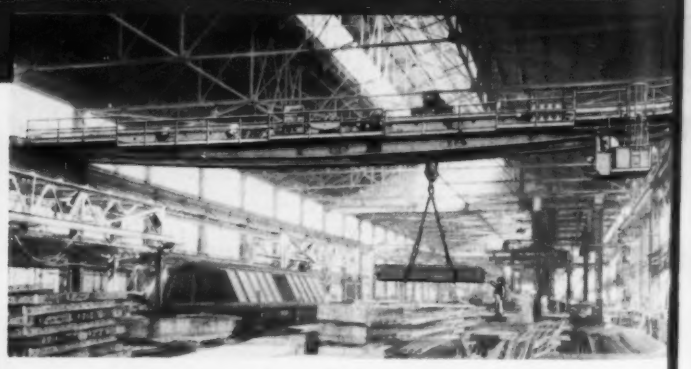
OTHER TYPICAL INSTALLATIONS OF EC&M A-c FREQUENCY RELAY CONTROL

THE ELECTRIC CONTROLLER & MFG. CO. CLEVELAND, OHIO

HEAVY DUTY MOTOR CONTROL FOR CRANES, MILL DRIVES AND MACHINERY • BRAKES • LIMIT STOPS • LIFTING MAGNETS AND AUTOMATIC WELD TIMERS

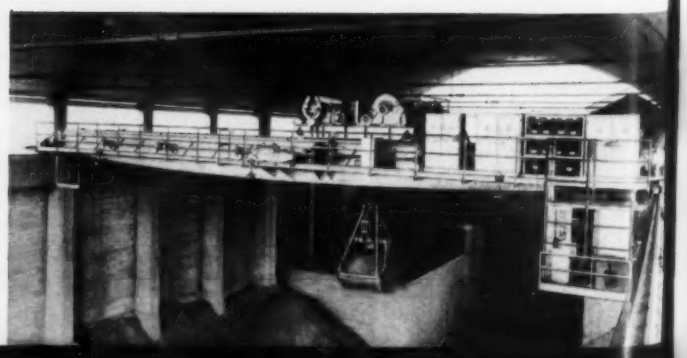


Many cranes in a tank arsenal are equipped with EC&M A-c Dynamic Lowering Hoist Control, which gives accurate control in handling turrettops, etc. during assembly of the tanks and when tanks are ready for shipment.



Accurate control in inserting and removing heavy dies in large presses as well as handling stock is the task of this EOT crane in southern railroad-car-manufacturing plant.

2-Motor Bucket Crane with EC&M Contra-Torque Control installed in one plant of large cement company. Similar cranes are in use in two other plants of this company.



THE ELECTRIC CONTROLLER & MFG. CO., CLEVELAND, OHIO

STEEL'S BID FOR VICTORY

American Rolling Mill Co.

By Charles R. Hook

PRESIDENT

▲ THE American Rolling Mill Company, operating at capacity on war steels, has but one paramount desire in this crisis. That is to do its full part in helping to win the war. Every resource of the company has been explored to further this effort. Using every tool at hand, and with the understanding and cooperation of a loyal organization, the company has been able to shift, quickly, to war production and to maintain operations at record-breaking levels.

Armco's peacetime output of flat rolled products represented an interdependency with America's normal standard of living. Manufacturers of refrigerators, stoves, automobiles, bathtubs, and hundreds of other products made of iron and steel sheets, were the major consumers of the company's products. When war crashed upon Europe in September, 1939, many persons, foreseeing the acceleration of our war armament production asked, "How can sheet steel makers keep their plants going full blast now?"

The story of how Armco did keep going—as a major producer of vital war material—is a sample of the initiative which has always characterized American industry.

Armco's mills were primarily designed and built to make high quality light gage products. The armament program, at the outset, stressed the need for structurals, plates, bars and similar commodities. However, to the informed it was obvious that tremendous tonnages of sheet steel would be needed ultimately. Anticipating this demand, the company worked closely with customers, helping them convert their facilities to the manufacture of war equipment and, through its market development department, kept customers posted on the procedure necessary to obtain government war contracts.

In a large measure, the same grades of open hearth steel, rolled on the same equipment, found a multitude of applications in the armament program. Only a change in finishing specifications was needed.

The mirror-like finish which had characterized much of the company's output wasn't wanted, so Armco forgot such finishes for the duration. The company increased gage within the limits of its equipment and rolled sheets for ambulances, cargo trucks, reconnaissance cars, jeeps, helmets, shell boxes, exhaust manifolds for planes and tanks, and many other military items. The demand soared for electrical steel sheets for motors and generators and many other vital parts of war machinery. An insatiable demand arose for stainless steel. Participation, generally, in the armament program grew.

Expansion of Capacity

Meantime, officers of the company kept in almost constant touch with national defense officials in Washington to determine what else it was essential for the company to do to enable its plants to reach maximum production of items needed in the program. Given an outline of what was desired, the company immediately began to work out the necessary program of construction to modernize and fully round out its facilities.

Washington was particularly anxious to create some additional ingot capacity, located away from the highly industrialized centers, for decentralized plants are less vulnerable to attack. With this in mind, the company arranged for the construction of an entirely new steel plant in Texas, to be operated by a wholly-owned subsidiary, the Sheffield Steel Corporation of Texas. The first heat from the open hearth furnaces of this plant was tapped in the spring of this year.

It was also evident that the ambitious armament program would tax facilities for making pig iron. To strengthen the nation's effort, the company authorized the construction of a new blast furnace at the company's Ashland, Kentucky, division. This furnace, one of the most important additions to pig iron production since the emergency started, was started August 20th and is now in full production.

Meantime, the company effected a broad program of improvements to existing facilities. At Ashland, in addition to the blast furnace, the mill for making heavy hot-rolled sheets was completely revamped. Under war the program the demand for hot-rolled sheets was greatly increased. Rolling and processing facilities at the Butler, Pennsylvania, division were improved. Additional coke ovens were completed at Hamilton, Ohio, plant and the No. 2 blast furnace there was rebuilt.

On the heels of this, it became obvious additional capacity for making alloy steel was needed. The story of how Armco assembled an electric furnace alloy steel plant in Middletown is one of the most interesting chapters in Armco's war history to date. Early in 1941 Armco learned that the Naval Ordnance plant at South Charleston, West Virginia, which had been idle since World War I, was being revamped and three electric furnaces were to be scrapped. Permission was obtained from the Navy Department to purchase and dismantle the furnaces. Sixteen carloads of parts were shipped to Middletown. In Cincinnati, a used building was located, equipped with two overhead cranes, which company officials felt would be suitable for the housing and operation of the three furnaces. The building was purchased, dismantled, shipped to Middletown, and reconstructed. An old charging machine was purchased and rebuilt.

In the interest of the nation's war effort, Armco took these steps, costing several hundred thousand dollars, without a single signed contract or even definite assurance it would be given a green light for actual operation of an alloy plant. Negotiations with the Navy were consummated by Armco purchasing the furnaces and miscellaneous equipment;

the alloy division of the then O. P. M. was convinced that through proper reconstruction of the furnaces the company could help defeat the airplane propeller bottleneck with alloy steel; the Defense Plant Corporation gave Armco a contract to erect and operate an electric furnace plant.

As a result of its early and independent action, Armco was in production of alloy steel on June 1 this year, less than seven months after the defense plant contract was signed, and today is a major producer of propeller blade steel. The only new equipment in the alloy plant consists of electric transformers.

Research Aids Conversion

While the company's manufacturing facilities were being geared to the crisis, the research department cooperated actively with its assistance in working out the problem involved in the production of steel for cartridge cases, airplane propellers, armor plate and various other products. Converting annealing furnaces to carburizing furnaces, the company is now making armor plate to protect our pilots.

One of the outstanding adaptations of Armco is the company's bomb shelter. Made of heavy corrugated steel, regularly used in bridges, tunnels and heavy culverts, these shelters are now being produced for the protection of both men and munitions at our advanced bases.

In the drainage field, where the company has been a large supplier of iron and steel culverts, a revolutionary stride has been made in the interest of the war effort. With the rising demand for steel of all kinds, it became apparent that a substitute must be found. It was. Armco developed an all-wood culvert which is designed to serve for the duration and conserve steel for other war uses. On permanent installations, the conventional steel culvert can readily replace the wood structure—after the war.

Converting, adapting, building, Armco has gone full steam ahead in its war effort. The volume of production in all phases of the company's operations is at all-time highs. Records have been broken and rebroken with a frequency which has brought national recognition to every operating division.

For five consecutive months the Hamilton plant has set records for production of pig iron. Blast furnace builders said months ago the "maximum" has been reached. But the record breaking continues. The Ashland Division has set more than 1,000 production and maintenance records since Pearl Harbor. These performances are typical.

Plant Protection

When war broke out in 1939, the company contacted the Federal Bureau of Investigation to find the best defense against possible sabotage. Many precautions were suggested, but the F. B. I. made it clear that the best plant protection is a loyal, interested organization. In that respect, Armco is most certainly fortunate. With a record of never a minute of time nor a pound of production lost through a dispute between men and management, Armco's employee morale continues to be excellent. This spirit has been evidenced not only in the record-breaking but in the speed and efficiency with which many war-born activities have been assimilated.

All Armco plants are thoroughly organized in respect to volunteer fire, police, air raid, and first aid units, etc. U. S. O., Red Cross and War Bond drives have been over-subscribed.

It would seem that with all these responsibilities some of the regular activities would fall by the wayside. On the contrary, the attendance at training classes has been consistent and larger; the company's safety record has shown improvement. The increased attendance is not made up of new employees by any means, as evidenced by the fact that over six hundred foremen have taken the "How To Teach A Job" course in connection with the Training Within Industry program under the auspices of the War Production Board. The desire to adhere to safety practices, learn first aid, or improve methods of doing a job, has sprung from the same "win the war" spirit which has set many phenomenal records.

War production drives are in operation at all plants and have received hearty support.

In effect, such drives were in operation long before Mr. Donald Nelson proposed that they be established. In July, 1941, an Armco Defense Committee was formed to coordinate all activities related to the armament program. It was composed of 2,000 members of management and men working together to assure delivery of Armco goods to the armament manufacturers. This committee was actively operating a comprehensive program when the Japs raided Pearl Harbor. Later, when Donald Nelson proposed war production drives, the War Committee took the new responsibilities in unbroken stride. Hence the war production drives were off to flying starts.

One of the early activities of the original committee was the community scrap campaign idea which currently is receiving national support. The first campaigns of this kind were conducted in the communities in which Armco plants are located and pointed the way toward the feasibility of a broad application of the idea.

A survey of Armco's war effort is, of necessity, a correlation of many things. A detailed report would be voluminous. It suffices, however, that the company has not merely kept abreast of the sudden changes which have recently characterized our national scene, but has constantly anticipated future needs.

The American Rolling Mill Company's current flow of basic war material is the answer to the question, "How can Armco keep its plants going full blast now?"

Typical of the resourcefulness of the free enterprise system, Armco has taken the tools it had on hand and made them hum; has rebuilt some and built others new. This, together with the spirit of the men in the plants, has contributed, importantly, to the deluge of war material which, collectively, will mean victory.

Two of four 15-ton, 120-foot span all-welded Cleveland Cranes in the Cold Reduced, Hot Strip Finishing and Shipping Departments of a large steel mill. The cranes are controlled from a cab at center of the bridge and travel at a speed of 500 F.P.M.

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CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

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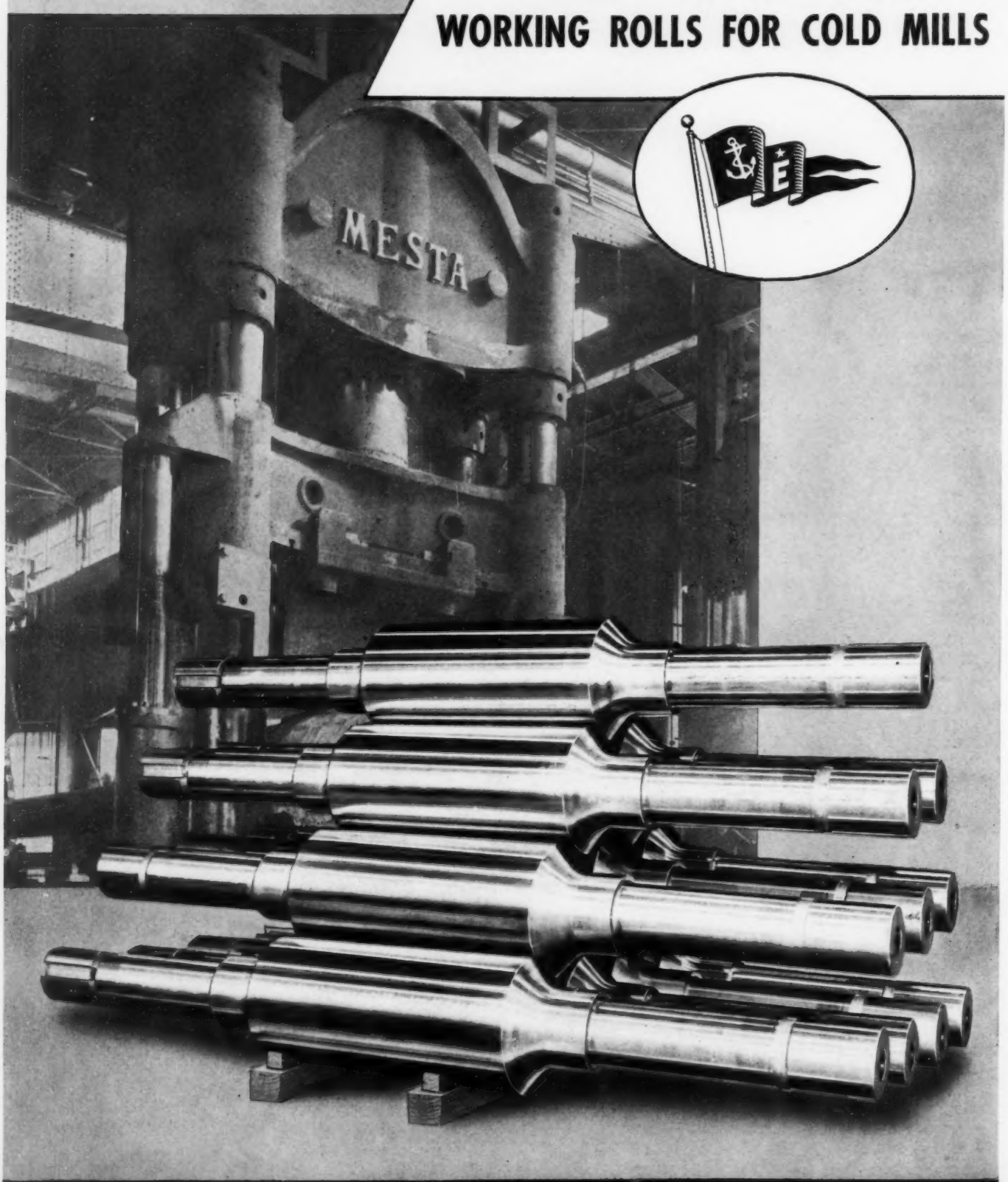

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Aids STEEL in its bid for VICTORY

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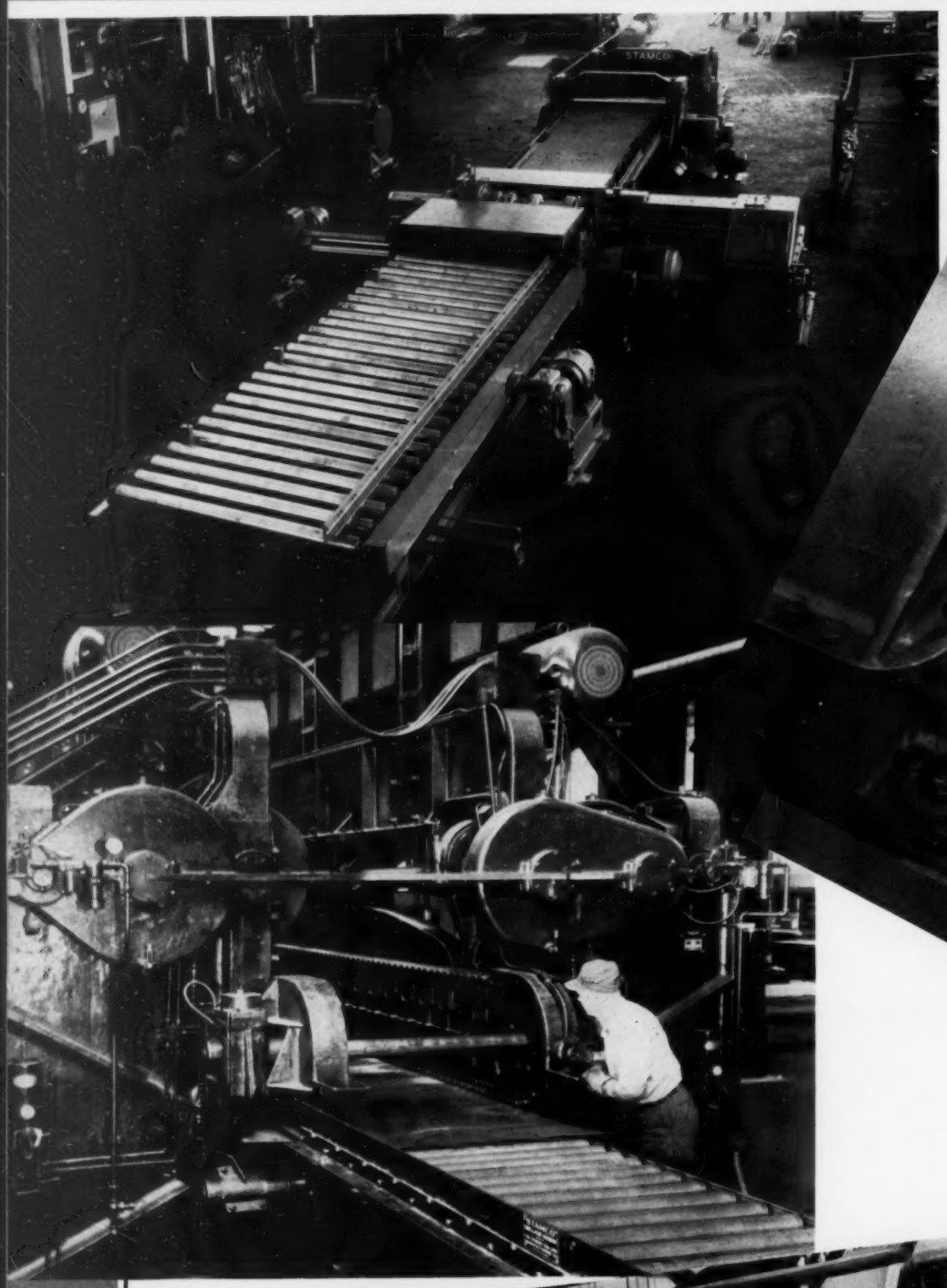

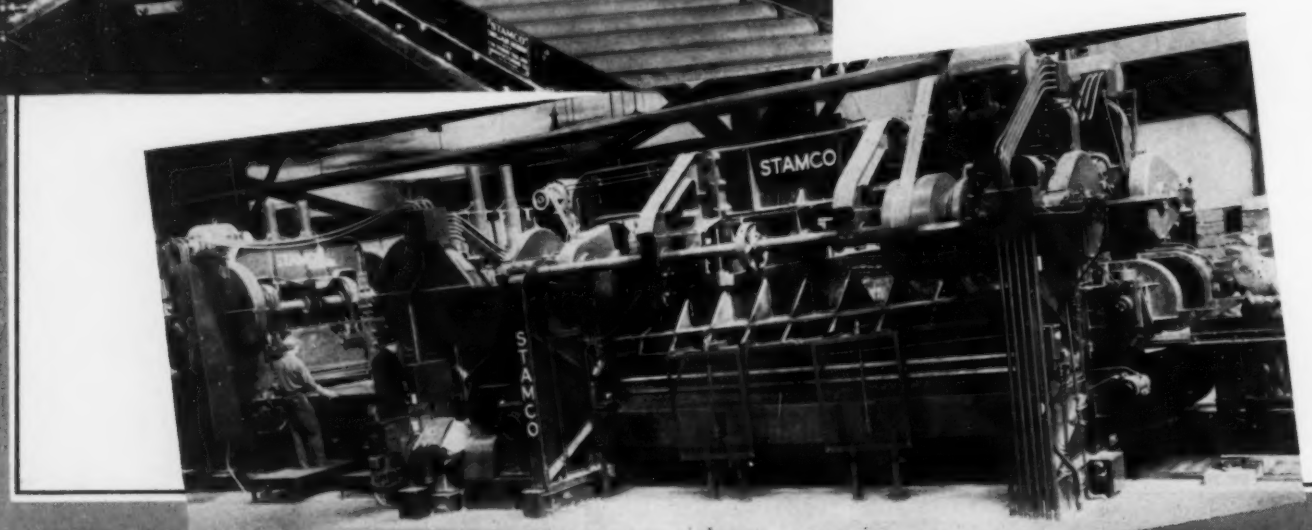

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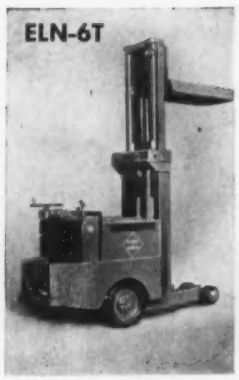
AVAILABLE IN STANDARD TYPES AND SIZES

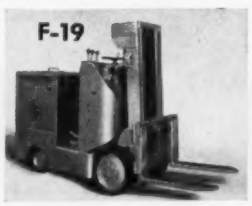
LIFT TRUCKS

Type	Capacity	Overall Length	Overall Width	Platform Size Length	Platform Size Width	Height at Low Position	Lifts	Turns Intersecting Aisles	Approximate Weight with Power Unit
EQ-4	4,000 lbs.	87¼″	31¼″	41″	18½″	7″	3¼″	50″	2,900 lbs.
EP-4	4,000 lbs.	112½″	38″	54″	26½″	10½″	6″	64″	4,100 lbs.
EP-6	6,000 lbs.	119½″	42¾″	54″	26½″	10¾″	5¾″	69″	4,600 lbs.
GEP-6 (Gas)	6,000 lbs.	125⅞″	42″	54″	26½″	10¾″	5¾″	72″	4,050 lbs.
EP-10	10,000 lbs.	129″	42¾″	60″	26½″	11″	5¾″	71″	5,500 lbs.



TIERING TRUCKS

Type	Capacity	Overall Length	Overall Width	Platform Size Length	Platform Size Width	Height at Low Position	Height Overall	Lift	Turns Intersecting Aisles	Approximate Weight with Power Unit
ELN-6T	6,000 lbs.	129 7/16″	42¾″	54″	27″	11⅛″	83″	113″	70½″	7,000 lbs.
ELN-6	6,000 lbs.	126″	42¾″	54″	27″	11⅛″	83″	62″	69″	6,300 lbs.
ELN-10	10,000 lbs.	137½″	43″	60″	27″	11″	95″	69½″	76″	7,500 lbs.



FORK TRUCKS

Type	Capacity Up to	Long Load	Overall Length (36″ Forks)	Overall Width (36″ Forks)	Telescoping Truck Lifts Up to	Height, Uprights Collapsed	Turns Intersecting Aisles	Approximate Weight with Power Unit
F-19T	6,000 lbs.	60″	123″	46″	117″	83″	76″	12,200 lbs.
F-25T	10,000 lbs.	48″	141″	51½″	100″	83″	86″	15,500 lbs.
F-23T	5,000 lbs.	42″	118¾″	41″	117″	83″	70″	9,300 lbs.

CRANES

Type	Capacity Lbs.	Capacity @	Overall Length	Overall Width	Boom	Slews	Platform Size Length	Platform Size Width	Platform Size Height	Turns Intersecting Aisles	Approximate Weight with Power Unit
C-4	3,000 lbs.	7′	107¾″	50″	12′-19′	292°	15″	41″	17¼″	69″	10,800 lbs.
CX-4	6,000 lbs.	7′	134¼″	63″	12′-19′	204°	40⅜″	63″	16⅜″	94″	13,400 lbs.
C-Z	10,000 lbs.	5½′	132⅜″	64½″	12′-19′	296°	28¾″	50″	25¼″	88″	18,000 lbs.
EP-6C	2,000 lbs.	3½′	129⅜″	42¾″	5′-8′	180°	26½″	54″	10¾″	70″	7,000 lbs.

(Boom mounted on EP-6 Lift Truck)

Elwell-Parker concentrates on these basic types, to give you deliveries of Trucks and Cranes that will meet your scheduled requirements, saving or multiplying manpower to handle your War Loads. Ask Elwell-Parker Engineers to survey your Plant.

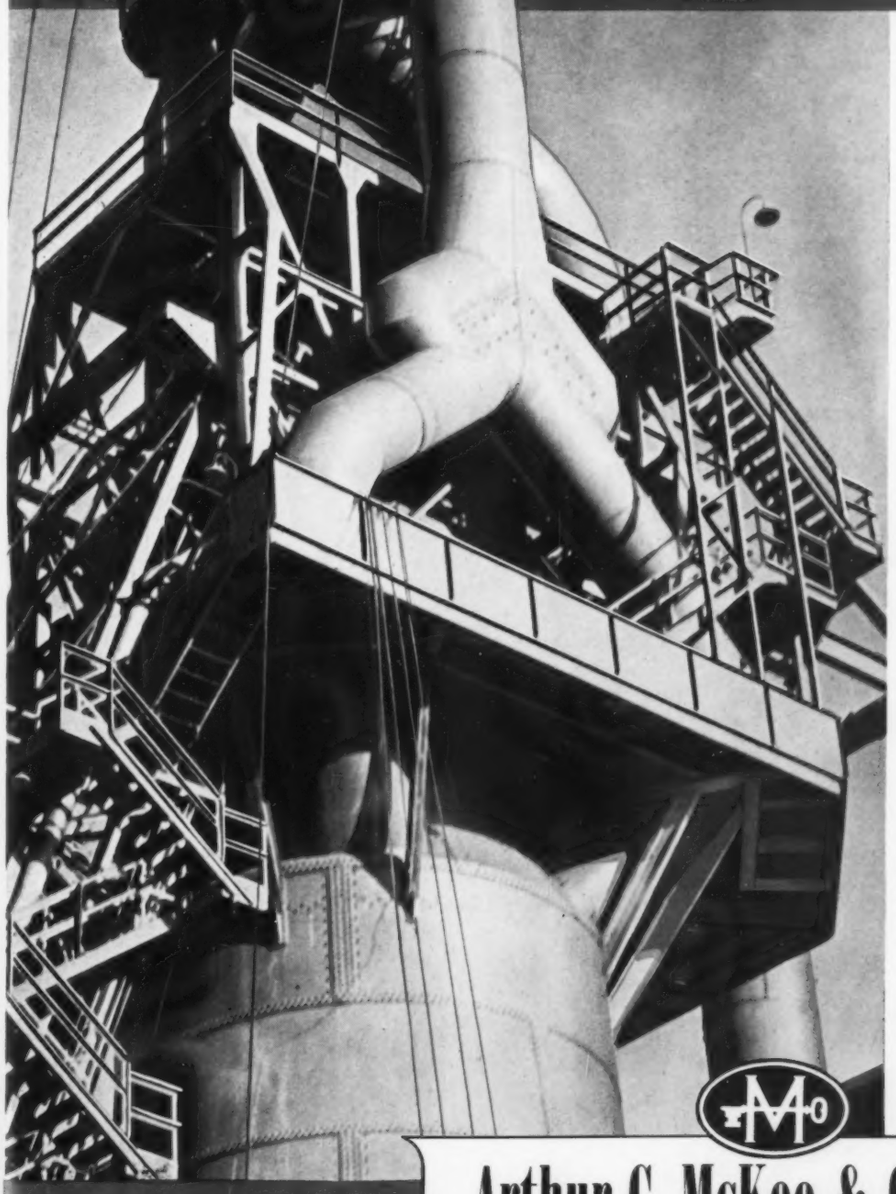
The Elwell-Parker Electric Company, 4504 St. Clair Ave., Cleveland, Ohio.

ELWELL-PARKER *Power Industrial* TRUCKS

ESTABLISHED 1893 • BUILDING POWER INDUSTRIAL TRUCKS SINCE 1906

Plan NOW to increase your Blast Furnace Efficiency

While Relining is in Progress



WHEN the time comes to reline your blast furnace, production must stop . . . but it may be possible to more than compensate for this loss of production.

During the shut-down period McKee engineers may be able to increase the capacity and efficiency of your plant by enlarging and modernizing your existing units while the furnace is being relined.

This necessarily requires advance planning so that all engineering is completed and material is available before the furnace is blown out. Thus, relining and alterations proceed simultaneously.

Consult the McKee organization *now* to determine the extent to which your plant efficiency can be increased while relining is in progress.

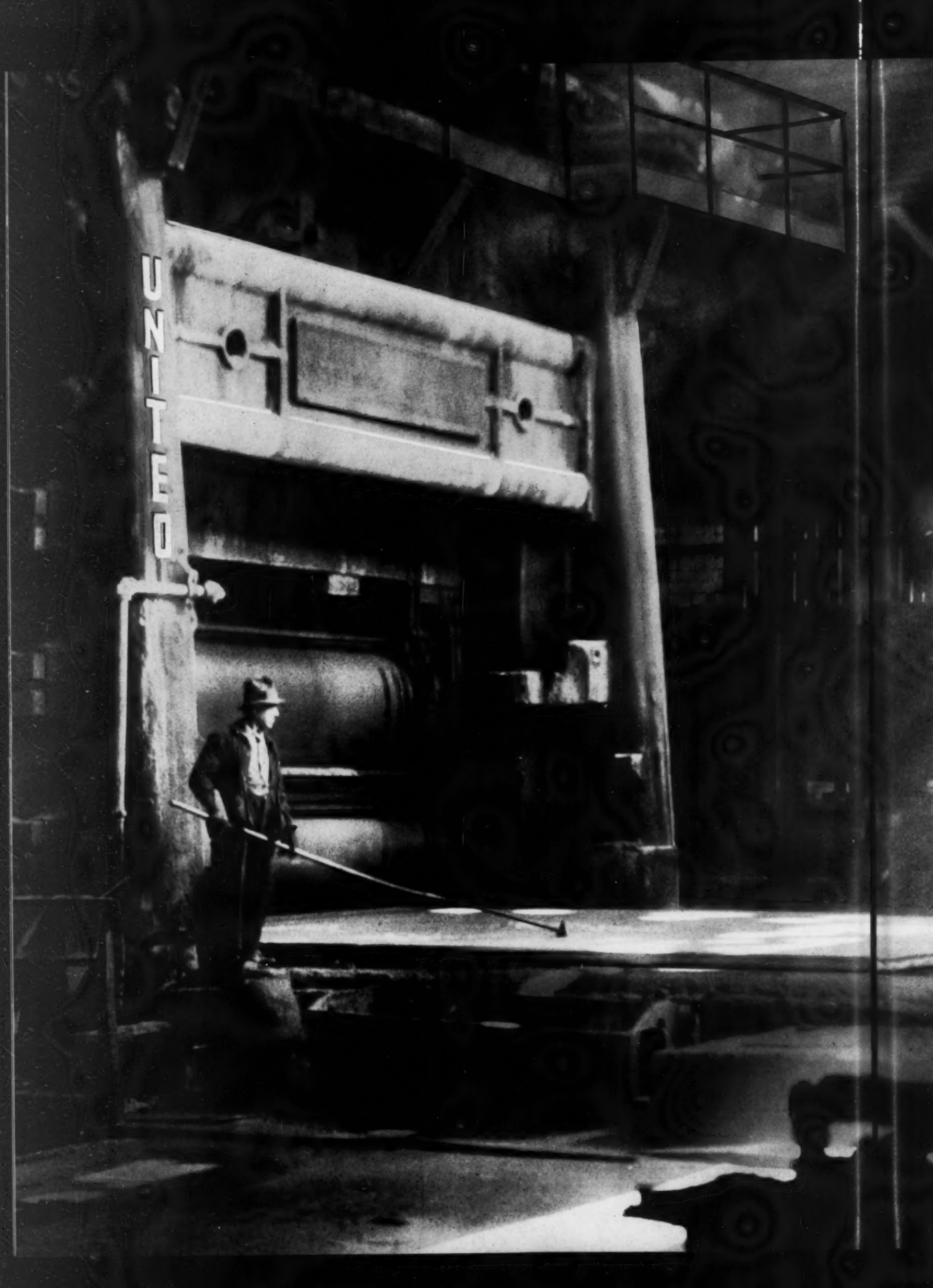
Arthur G. McKee & Company

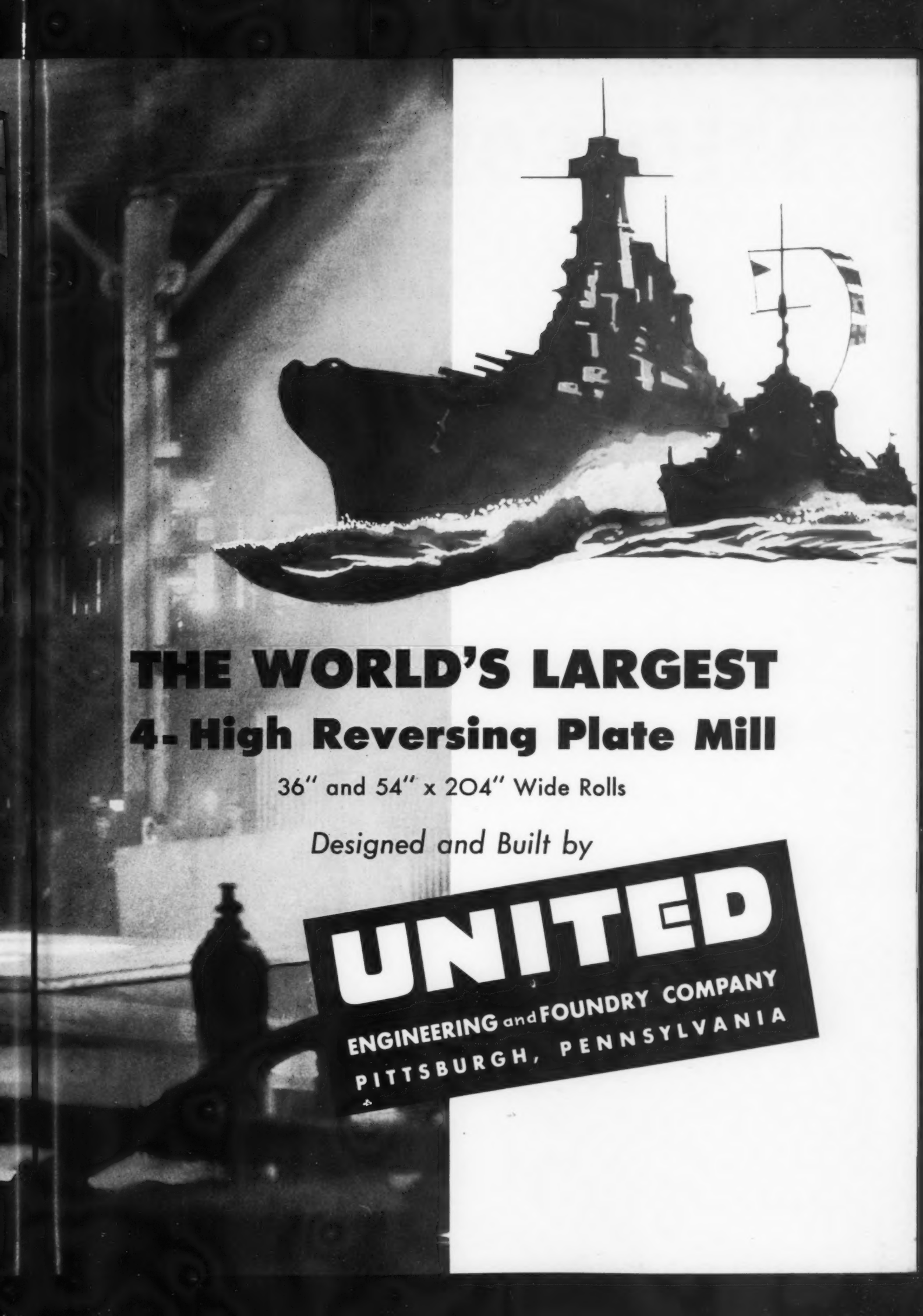
★ *Engineers and Contractors* ★

2300 CHESTER AVENUE • CLEVELAND, OHIO

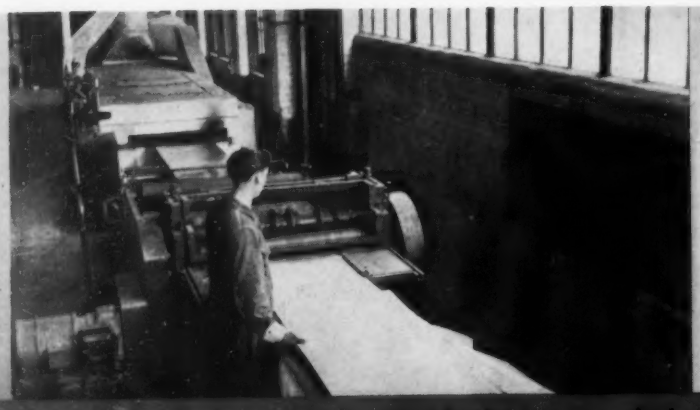
30 ROCKEFELLER PLAZA
NEW YORK, N. Y.

COMMERCE BUILDING
HOUSTON, TEXAS


UNITED

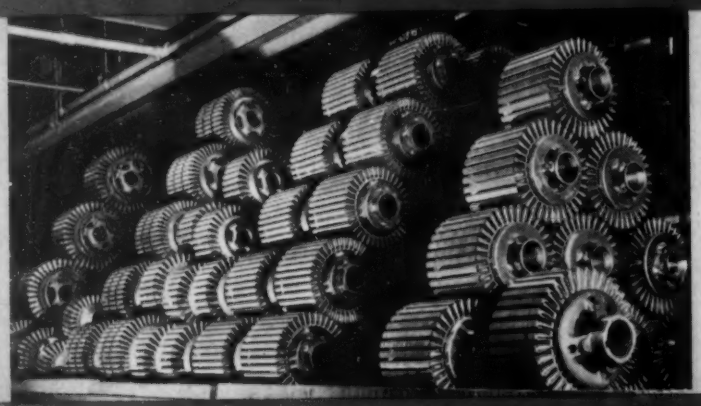

THE WORLD'S LARGEST
4-High Reversing Plate Mill
36" and 54" x 204" Wide Rolls
Designed and Built by
UNITED
ENGINEERING and FOUNDRY COMPANY
PITTSBURGH, PENNSYLVANIA

STEEL GOES TO WAR

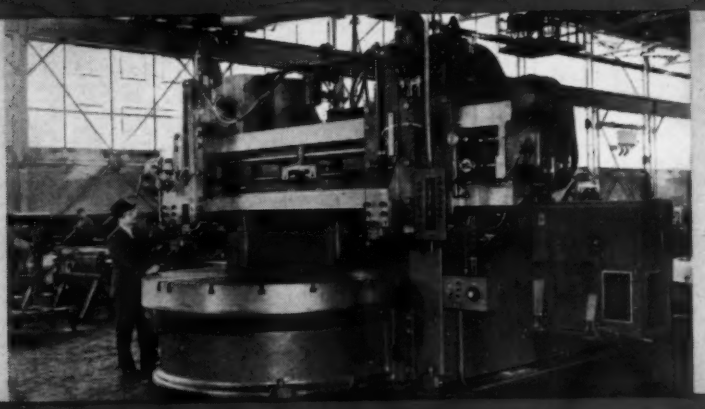


Illustrated here are electrical sheets on their way to be turned into stators and rotors of

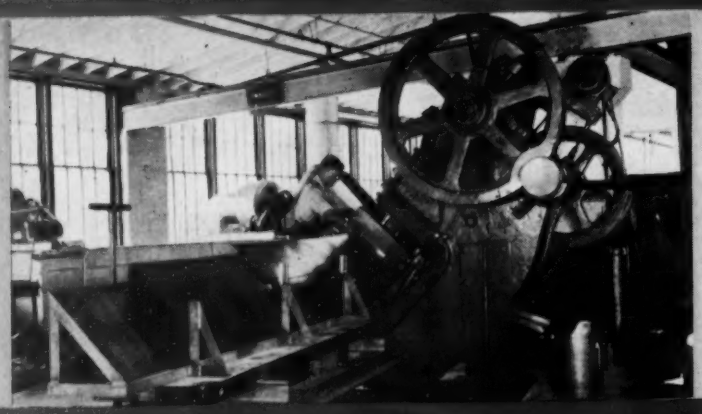
special Reliance A-c. Motors, the ultimate purpose of which will be to supply power for



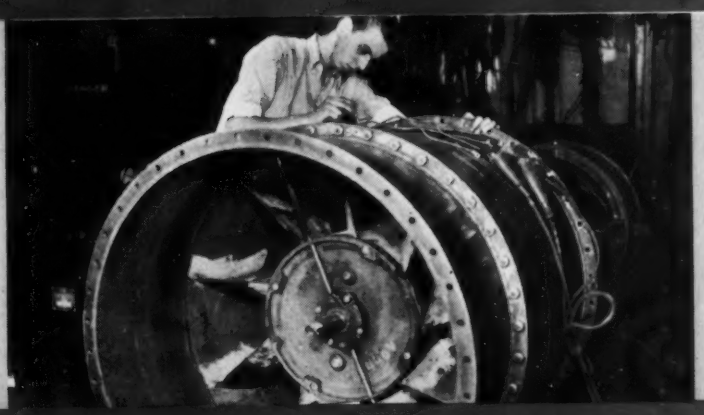
The electrical steel sheets in the d-c. armature cores illustrated above will take part in setting



new records for the production of tanks. In Reliance V•S Drives for 100" boring mills they

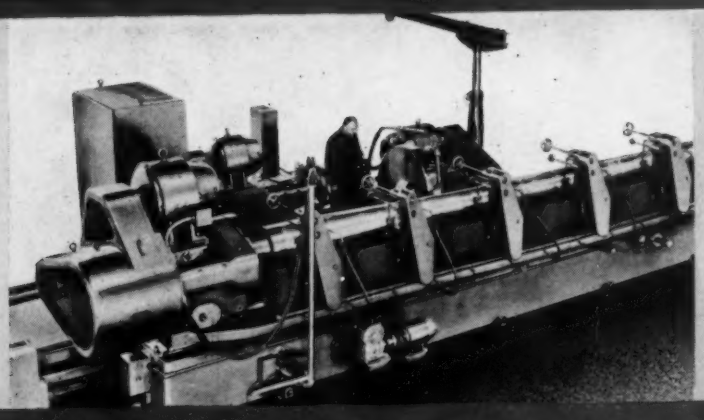


Armature core laminations from these electrical steel strips will form the heart of axial flow



fans, — a big new factor, especially on troop ships destined for the tropics. Using less space,

Armature shafts made from round bar steel do war duty in Reliance Motor-drives in-

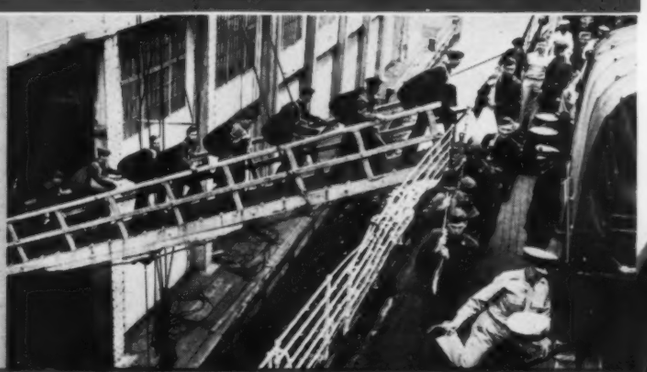


stalled on thousands of machines. An excellent example is this grinder, which is seen

IN RELIANCE MOTORS

aiming and launching torpedoes from U. S. destroyers. ★ ★ ★ ★ ★ ★

become a factor in providing motor-drives that are a lot *more than* power. ★ ★



they furnish more effective ventilation on every form of naval craft. ★ ★ ★ ★

here at work on a 48-foot gun barrel. ★ ★ ★ ★

Steel for Strength

Frames for D-c. Reliance Motors are rolled steel with feet of bar steel electrically welded. Frames of A-c. Reliance Motors are fabricated entirely of bar steel electrically welded. *Lots of strength*—no excess weight.

RELIANCE ELECTRIC & ENGINEERING COMPANY
1088 IVANHOE ROAD • CLEVELAND, OHIO

BIRMINGHAM • BOSTON • BUFFALO
CHICAGO • CINCINNATI • DETROIT
GREENVILLE, S. C. • HOUSTON, TEXAS
LOS ANGELES • MINNEAPOLIS
NEW YORK • PHILADELPHIA
PITTSBURGH • PORTLAND, ORE.
ST. LOUIS • SAN FRANCISCO
SYRACUSE, N. Y. • AND
OTHER PRINCIPAL CITIES

RELIANCE A-C D-C MOTORS

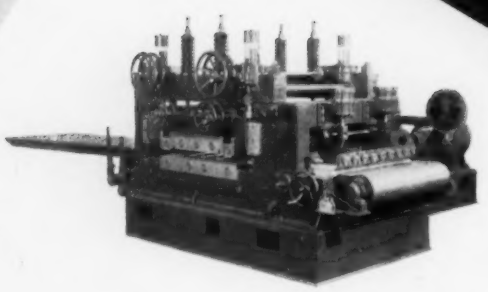
BLISS BUILT ROLLING MILL

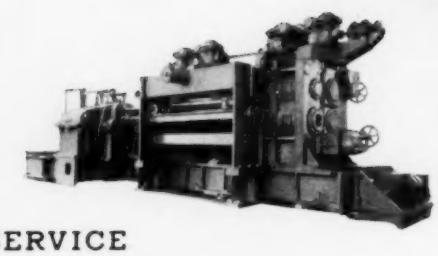
BROOKLYN, N. Y.

CLEVELAND, O.

SALEM, O.

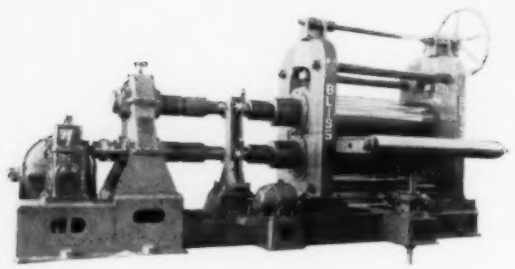
HASTINGS, MICH.





EQUIPPED FOR SERVICE

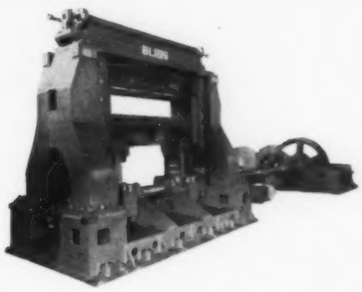
An earned reputation for sound engineering and precise workmanship in the construction of "Bliss Built" Rolling Mills and mill equipment is backed by one of the largest and oldest companies in the sheet metal working equipment field. "Bliss" Rolling Mill activities centered at the enlarged Salem plant are augmented by the heavy machining facilities of four other domestic plants.

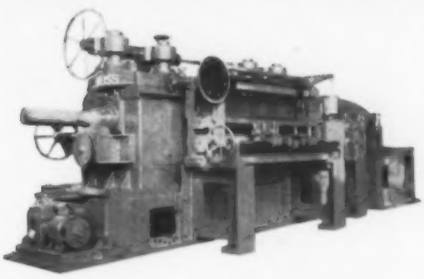


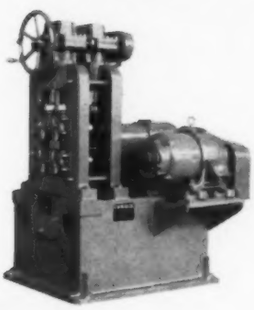
E.W. BLISS COMPANY

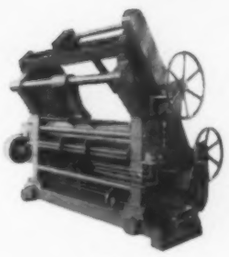
PRECISION PRODUCTION EQUIPMENT FOR

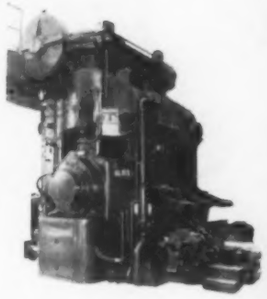
MILLS EQUIPMENT BEST BUILT

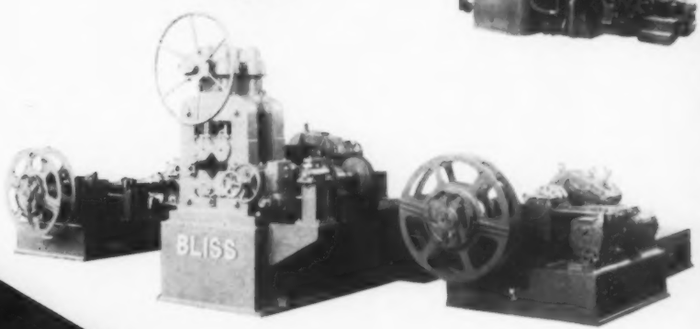




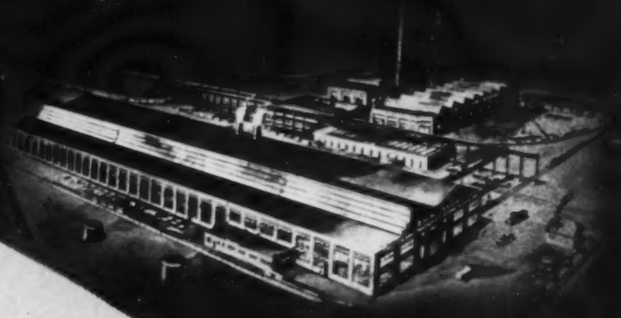








TOLEDO, O.



SINCE 1857

E. W. BLISS

AMERICAN OFFICES

BROOKLYN, N. Y.
CLEVELAND, OHIO
PHILADELPHIA, PA.
NEW HAVEN, CONN.
TOLEDO, OHIO
CHICAGO, ILL.
BOSTON, MASS.
DETROIT, MICH.
HASTINGS, MICH.
ROCHESTER, N. Y.
SALEM, OHIO

THE PLASTIC WORKING OF METALS

Steel from the sheet and strip mills comes into the Detroit plant of Chicago Rawhide, there to be fabricated into the retainers of oil and grease for industry, including the steel mills.

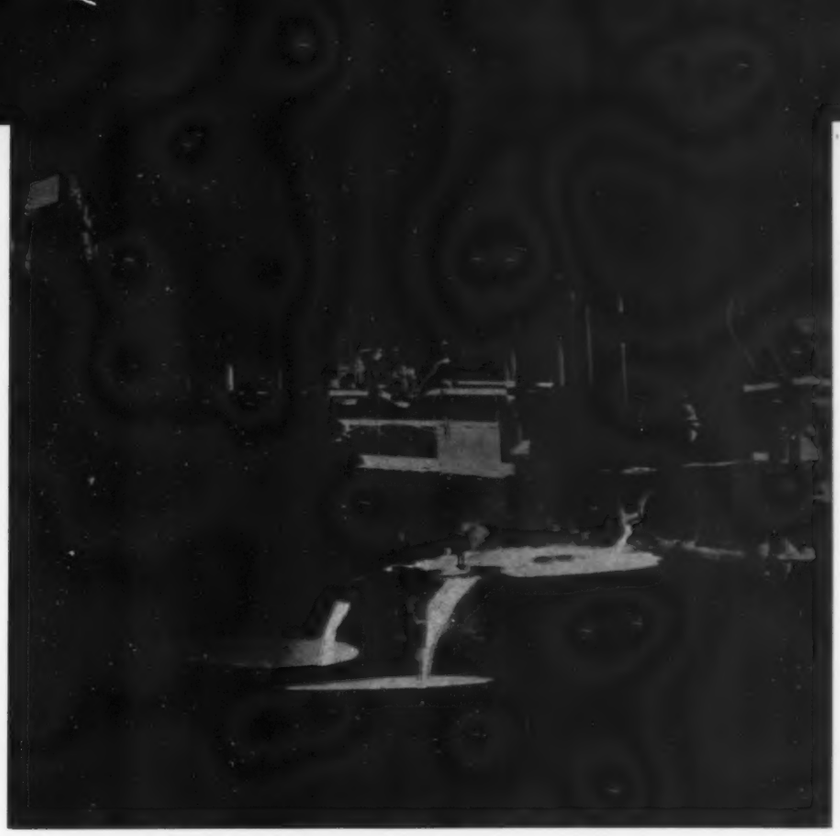
Back home in the steel mills these lubricant seals are protecting thousands of vital bearings from the smallest (1/4" OD) to the large 48" OD seals on the roll necks. They keep lubricant in the bearing housing and exclude all moisture, scale and air-borne grit. Without such effective protection, bearing maintenance cost in the steel mills would be many times what it is today.

CHICAGO RAWHIDE MANUFACTURING CO.

ELSTON AVENUE • CHICAGO, ILLINOIS

PHILADELPHIA • CLEVELAND • NEW YORK • DETROIT • BOSTON
PITTSBURGH • CINCINNATI

64 Years Manufacturing Quality Mechanical Leather Goods
Exclusively and now Sirvene Synthetic Products



MODERNIZE YOUR OPEN HEARTH FURNACES

YOU CAN INCREASE TONNAGE
REDUCE INGOT COSTS
BENEFIT THE QUALITY OF YOUR PRODUCTS

by using our Improvements, which include

VENTURI PORTS
SLOPPING BACK WALLS
DANFORTH-PETERSON CHECKER WORK
FUEL MIXING BURNERS
SODIUM FLUORIDE PROCESS FOR RIMMING STEEL

Open Hearth Combustion Company

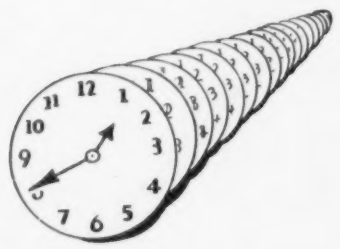
GEO. L. DANFORTH, JR., Pres.

Designers *Licensors* *Engineers* *Consultants*

310 South Michigan Avenue Chicago, Illinois

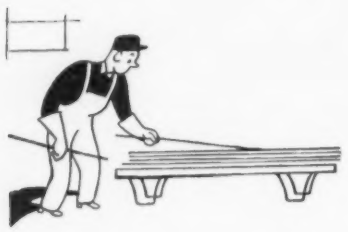
168 Hours per Week!

Modern industrial trucks are working 168 hours a week. This is necessary to keep war production lines adequately supplied with materials. Other trucks, not so modern and, up to this time, never even considered for such continuous service, can be batteried to give the same kind of service. Write our nearest office for suggestions.



Alibis are Seldom Alkaline.

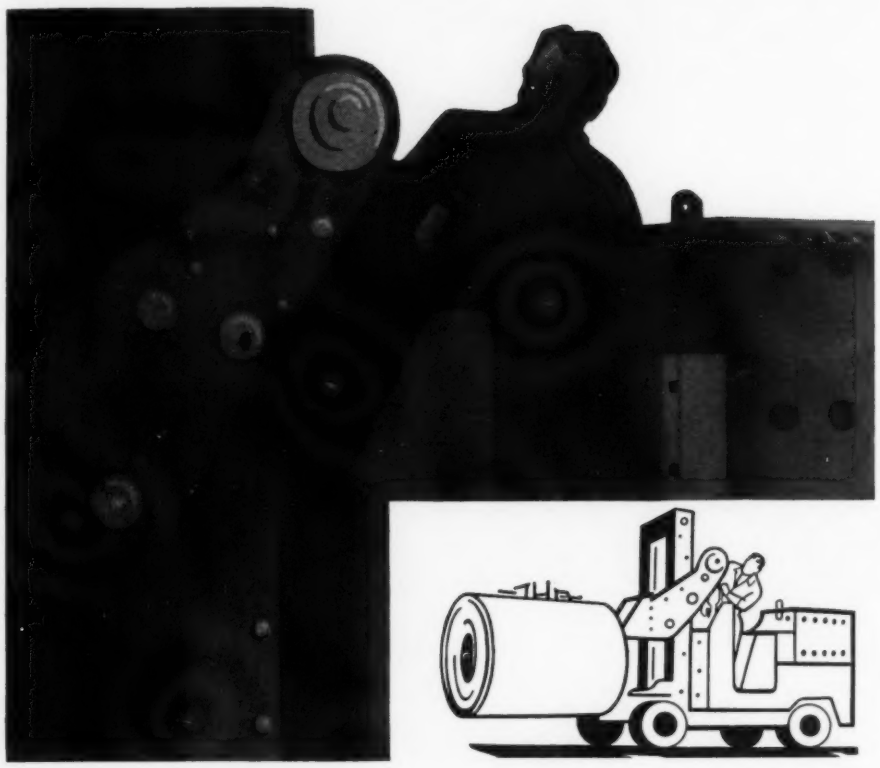
For every production dip there must be a suitable explanation. Few material-handling delays have ever been attributed to failure of an alkaline battery. Its performance is predictable. It does not fall down on the job without warning. On such reliability are production records written.



Skid Racks. Many war plants are producing parts machined to close tolerances which require careful protection against damage in handling through the subsequent processes. By the use of skid racks they have not only avoided spoiled work but have also saved many handling motions. And, they have avoided time losses that could never be retrieved. When a plant is on a war schedule, there's no time left!

Edison Storage Battery Division
Thomas A. Edison, Inc.
WEST ORANGE, N. J.

THIS POWER must not fail



Battery industrial trucks are literally the internal supply lines of our war industries. They keep materials on the move all the way from incoming to outgoing carriers. Their power-units are their strength . . . they must not fail.

And that's the biggest single reason why over half the battery industrial trucks of America are powered by Edison Alkaline Batteries. They provide the most dependable battery power the world has ever known, an Edison invention. Dependability is the reason for their success in mines, on railroads, throughout industry and aboard ship. Electrically, chemically, structurally, they are made to order for today's stringent demands.

INDUSTRY NEEDS THE DEPENDABILITY OF

Edison Alkaline BATTERIES

TOOLS *for*

GREATER PRODUCTION

On this page are shown various types and capacities of Brosius Auto Floor Machines, arranged to handle charging boxes for charging melting furnaces; equipped with tongs for serving heating furnaces, mills, hammers, presses, etc.; and designed as manipulators for manipulating pieces under hammers and presses, as well as charging and drawing the heating furnaces.

The machines are driven by an electric motor, while the rotation and tilting of the peel or operation of the tongs are accomplished through oil cylinders operated by a motor driven oil pump mounted on the machine.

The units shown in Figs. 1, 2, 3 and 4 receive their power from the plant supply through a flexible cable and rotating collector mounted on the mast of the machine, while the unit shown in Fig. 2 is self contained, receiving its power from a gasoline engine driven generator mounted directly on the machine.

All machines, both chargers and manipulators, are provided with anti-friction bearings, are rubber tired, and hydraulically steered, eliminating all fatiguing effort on the part of the operator. They require no tracks or runways and their movement is not restricted to any definite path. No provision, aside from a good floor on which to operate, is necessary for their installation. Extreme mobility is obtained as the tractor unit turns 180°, permitting the machine to turn on its own wheel base—a feature of great importance where operating space is limited.

These machines are built in capacities of from 2000 to 20,000 pounds, giving a range of designs to suit most any requirement.

Edgar E. **BROSIUS** *Company*

MANUFACTURERS AND DESIGNERS OF SPECIAL EQUIPMENT FOR BLAST FURNACES AND STEEL MILLS

PITTSBURGH, SHARPSBURG BRANCH, PA.

Brosius Equipment is covered by patents allowed and pending in the United States and Foreign Countries

Fig. 1 — 2000 lb. Manipulator

Fig. 2 — 6000 lb. Manipulator

Fig. 3 — 2000 lb. Tongs Charger

Fig. 4 — 4000 lb. Box Charger

K&R 9VS VERTICAL SHAFT *TWO PASS* STRAIGHTENING MACHINE

This machine is built in several sizes for straightening from ½" to 4" heat treated square bars and proportionate shapes.

CAPACITY

Heat Treated Steel 130,000 lbs. Tensile Strength

12 x 2 Flat on Flat

8 x 1 Flat on Edge

4 x 4 Square

These machines are employed for straightening tool steel and alloy bar stock where the production does not justify the use of a Combination Vertical and Horizontal Straightener, and they are also used for large bar and billet sections to substantially reduce the cost of straightening, as compared to bulldozer or gag press operations.

Manufacturers of:

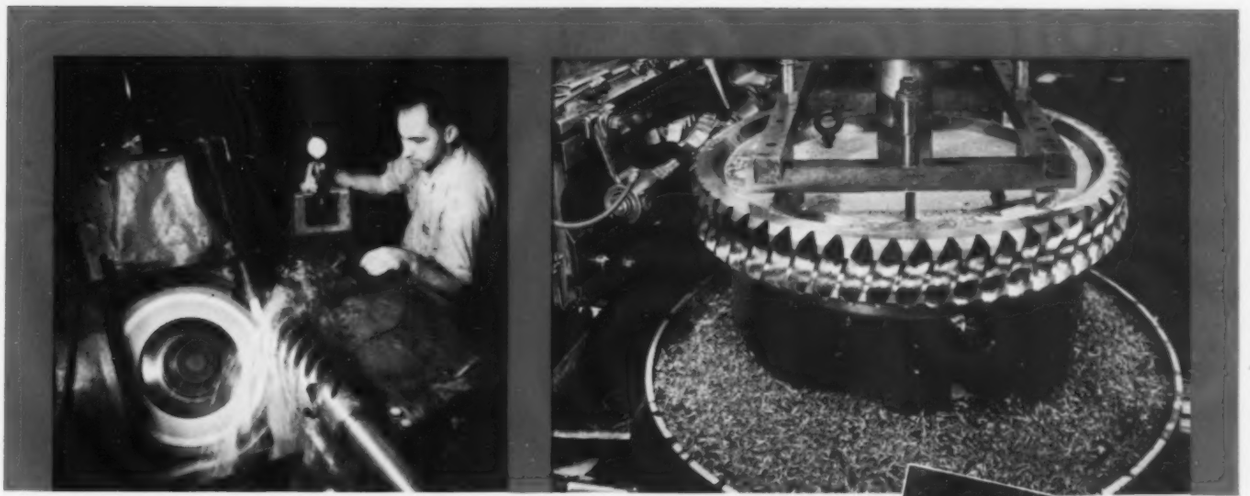
Cold Roll Forming Machines, Straightening Rolls, Bending Rolls, Gang Slitters, Edging Machines, Crimping Machines, etc.

KANE & ROACH

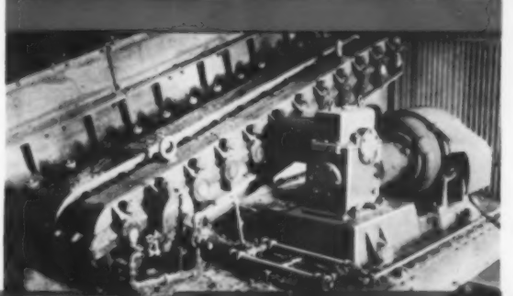
INCORPORATED

Syracuse, New York

Established 1887



Prepared for *Punishment* throughout the Mill



The precision operations of worm grinding and gear hobbing illustrated above are typical of Cleveland's forethought in producing Worm Gearing for enduring service in Steel Mills.

Even a bookful of pictures couldn't tell the whole story—for the priceless element of Successful Experience can't be photographed. But *you* profit by long years of knowing-how when you install Clevelands.

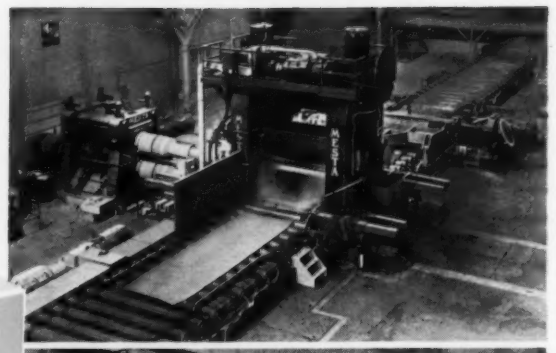
We began applying Worm Gearing on Steel Mill machinery 25 years ago. Today thousands of Cleveland Units are taking the punishment on all types of Mill equipment and the demand for Cleveland grows as steel production expands.

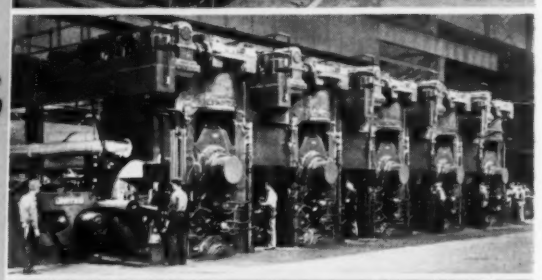
The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland, Ohio.

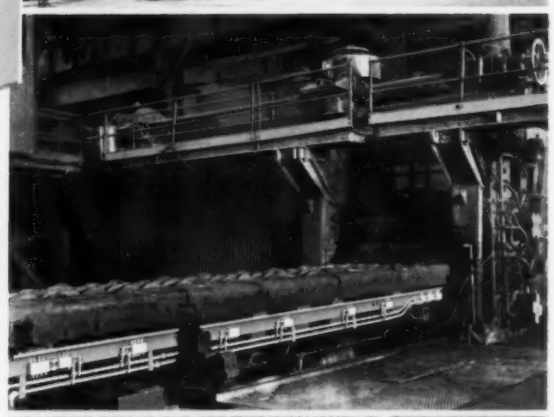
Affiliate: The Farval Corporation, Centralized Systems of Lubrication

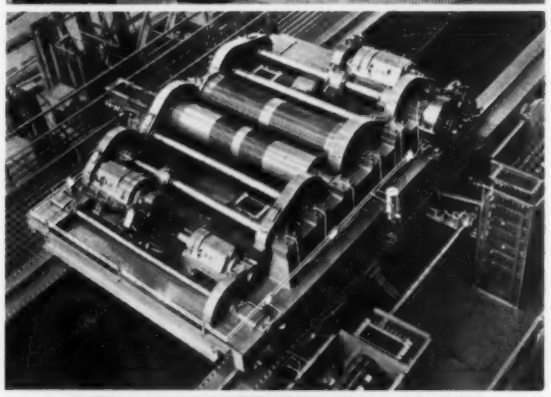
In Canada: PEACOCK BROTHERS LIMITED

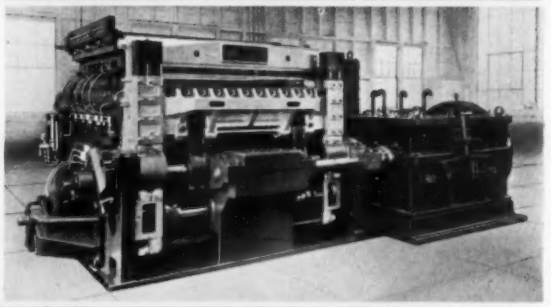
CLEVELAND WORM GEAR *Speed Reducers*











Twenty-four hour operation leaves you no time margin for shutdowns—either to lubricate, or to repair if you *fail* to lubricate. To keep your "Steel for Victory" schedules rolling, you must keep your bearings rolling too.

Install the Farval System and it will deliver lubricant to *all* of your bearings, on *all* of your equipment, *all* of the time. Proper lubrication by Farval will eliminate Mill delay and permit a faster and hotter rolling of steel.

Farval Systems save Lubricant, save Power, save Time, save Men and—increase your production.

Special Delivery
TO EVERY BEARING

There are more Farval Systems installed on Steel Mill Equipment than all other makes combined.

The Farval Corporation, 3278 East 80th Street, Cleveland, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Automotive and Industrial Worm Gearing

In Canada: PEACOCK BROTHERS LIMITED

FARVAL

CENTRALIZED SYSTEMS OF LUBRICATION

Sytematic INSPECTION *and* MAINTENANCE *of Steel Plant* ELECTRICAL EQUIPMENT

. . . . a system of preventive maintenance, embracing regular scheduled over-hauls, has worked very efficiently in the electrical department of Inland Steel Company . . . .

By W. A. Perry

SUPERINTENDENT ELECTRIC AND POWER DEPTS.

INLAND STEEL COMPANY

EAST CHICAGO, INDIANA

▲ HARDLY an issue of the Association of Iron and Steel Engineer's yearly proceedings has gone to press without one or more excellent articles by authors well versed in the art of plant maintenance. We were reluctant to accept the invitation to express our views on a subject so thoroughly covered from so many angles in these previous articles. However, the very word maintenance seems to act as a tonic to any man entrusted with the upkeep of equipment and, whether served in large or small doses, seems to be an engrossing subject that is never lacking in interest. Evidently there are many reasons why a discussion on this subject appeals to the men entrusted with the continuous operation and availability of the apparatus that keeps the wheels turning in the iron and steel industry, or any other industry for that matter.

The present discussion of systematic maintenance and inspection of electrical equipment is naturally based on experiences at the plant where the author and his co-workers are employed. Our plant is the usual steel mill having five blast furnaces, thirty-six open hearths, two hundred and seventy-three coke ovens, three blooming mills, structural mills, bar mills, merchant mills, sheet mills, two strip mills, tin mills, plate mill, cold mills, galvanizing department, rail mill, tie plate and splice bar, with all the necessary warehouses, finishing and auxiliary equipment to make a well balanced steel plant. Our maintenance problem is perhaps a little less than some readers might experience, and perhaps a little more than some others.

This subject is not to be handled with the thought in mind of having every one go and do likewise. Far from that. We are just giving some idea of the methods submitted by the different workmen, foremen and supervisory personnel in our electrical division in order to keep from doing work which had not been previously arranged for, but to do it at a pre-determined time in a more thorough and better manner, thus making substantial savings in time, material and labor. There is no better time than the present to give credit to all these men for their many fine suggestions, close inspections and hearty cooperation which has made and is now keeping this system in successful operation.

It would indeed be a story for Ripley if two plants were to be found which had the same or nearly the same apparatus in service and each had a management, or so-called front office, with a broad cooperative understanding of what is required and necessary to keep essential apparatus trouble free. Likewise it would be another story for Ripley if he were to find a plant without the same idea in view, that is, keep all the apparatus operating all the time without any delay and have no repair or maintenance cost. This is obviously not at all possible and eventually would lead to an

end that has been made famous in the poem titled "The Wonderful One Horse Shay." Therefore, it is our problem to acquaint the management with the necessity of continuous maintenance, little or no repair work and avoid the end as outlined in the poem.

Webster left us with a few definitions of words that may well be reviewed at this time. He had this to say about maintenance: See maintain, to hold or to keep in condition; to keep up; not to suffer to decline or fail. And now another word from the same source, repair: to restore to a sound or good state after damage, waste, injury or partial destruction. The first is what we hope to attain and the second is what we hope to avoid.

If you have had the pleasure of working in one of the early and perhaps some of the present electrical shops the above definitions will assist you in understanding why they were called electric repair shops. Equipment seldom, if ever, arrived at the shop until it was in need of major repairs. We all know how easily and quickly the need for major repairs can and does develop in a piece of electrical apparatus that is not at least partially properly maintained along our present line of thought. We are looking forward to the day when we are in a position to paint on our shop building wall the sign, "Electrical Maintenance Shop."

We have listed, but not in order of importance, a few reasons why planned systematic maintenance pays:

It gives us an opportunity to spend a relatively small amount of money on each of a number of pieces of apparatus at a predetermined period, thus giving in a measure controlled cost.

We are able to maintain a more uniform level of employment, thus retaining a better, more satisfied class of workmen, who are naturally in favor of this system and work whole-heartedly for its success. For this reason they are more thorough and conscientious in their routine inspections, realizing no amount of planning will eliminate failures due to neglect or oversight on their part.

It enables us to work the men on turns and parts of apparatus where the most good can be accomplished. This assists us to develop a well instructed crew so that work progresses with equal dispatch on night or day turns.

It gives us employes familiar with routine and special work, enabling us to maintain a satisfactory no-injury safety record. Due to the rush and pressure put on during breakdown jobs the chances of injuries are somewhat greater than on planned work.

It gives to us an opportunity to rotate spare apparatus. Thus, all spares are also kept in excellent condition.

It gives our men an opportunity to obtain a thorough working knowledge of the details of each part of the apparatus they normally operate that has to be serviced on location, for these men assist in all field maintenance work.

It enables us to locate, avoid or correct conditions which might eventually result in a major breakdown, interrupting mill schedules and interfering with delivery to customers of finished products.

On main drives and auxiliary apparatus we avoid costly repair jobs, both in material and labor, and are able to lower our stock of necessary renewal parts without a feeling of insecurity.

It enables us to do this planned maintenance work when the production department is in a position to satisfy customer's requirements and still allow us ample time for a thorough job.

Then comes the seemingly best part of all. If at home, we are not worried when the telephone bell rings. We know it is not a call from the mill pertaining to a breakdown.

Our need of a change in methods became apparent with the increase in the number of connected motors in the plant and a more than corresponding increase in kw hr per ton of rolled product shipped. Our repairs also indicated the increased use (or abuse) of electrical apparatus, as well as the fact that our apparatus was being pushed closer to its continuous rating. Apparatus that had previously performed satisfactorily was now failing in service and requiring such extensive repairs that our shop was kept busy 24 hours a day and 7 days a week. Main drives failed and caused lengthy mill delays just when they were needed the most, as well as very expensive material and labor repairs. Auxiliary apparatus was leading the race in delays. Admittedly these were shorter but they were more frequent and annoying delays than those experienced with the main drive apparatus. It is true we were running and producing good tonnage — in fact, we believe, no worse and no better than other plants in our district. However, we felt it was a serious problem and that maybe a change for the better could be made.

In fact, many of us thought there had to be a change, and perhaps it would not be difficult to put through a change after the idea had been thoroughly sold. Working to that end, we held group meetings in an endeavor to sound out everyone concerned on the subject and obtain ideas along a corrective line. At these meetings foremen working in the electrical division were given an opportunity to express freely their ideas and views, as well as to hear what we had in mind along these lines.

At first it was pretty much the old story of the pot calling the kettle black. Everyone thought, and almost believed, he was doing a fine job but was receiving very little cooperation from the other fellow. The driven apparatus was in such condition that the vibration and jar would ruin any electrical apparatus. The shop was turning out faulty jobs and they in turn claimed the field men did not properly inspect and take care of good jobs when they received them. You have heard it every day — it is called the grand old American game, "passing the buck." Nevertheless it was interesting and enlightening in that many beneficial ideas were obtained. We were led to believe if we could change a motor before it had failed in service that we wouldbe the victors in the battle. Seemingly this would all require closer and more frequent inspection, intensive and intelligent planning and a simple workable system of records. It seemed to be rather ridiculous to change a motor that appeared to be performing satisfactorily, let us say that had nothing wrong with it. But working upon motors that supposedly had nothing wrong with them has prevented them from failing in service. This we have found to be only too true. When a failure has occured the resultant damage is so extensive we seldom arrive at a true reason for the failure. Working upon so-called good apparatus we have found these failures

in their inceptive stages and often times by a simple change of materials or methods have overcome many weaknesses in apparatus and warded off much expensive repair work.

The few right moves we made in the early part of this program that gave good results and the many moves that ended in no gain need not be gone over at this time. Needless to say that at times we were almost at loss to find the proper methods of going about different jobs or retaining simple records pertaining to these jobs. However, we all stayed with the task on hand and feel that we now have a successful system in operation.

Now we will list some of the information we have found necessary to carry on this system:

In each department the electrical foreman has manufacturer's data sheets and blueprints pertaining to equipment in that department. He has a general plant electrical instruction book containing much helpful information pertaining to motors, generators, brushes, wire, conduit, methods, systems, safety, office routine and personnel problems.

He has a book containing the nameplate readings of the electrical apparatus in that department, such as motors, control, brakes, limit switches, resistor banks — values thereof, pinions, couplings, pulleys, units driven as well as Inland numbers on the frame and armature.

He has a book listing by departments all motors in service as well as spares for these motors. This enables him to procure a spare from another department in case he does not have suitable spares in his own department.

Each workman is assigned by the foreman a definite amount of apparatus for which he is held responsible. He keeps a book record of all equipment assigned to him.

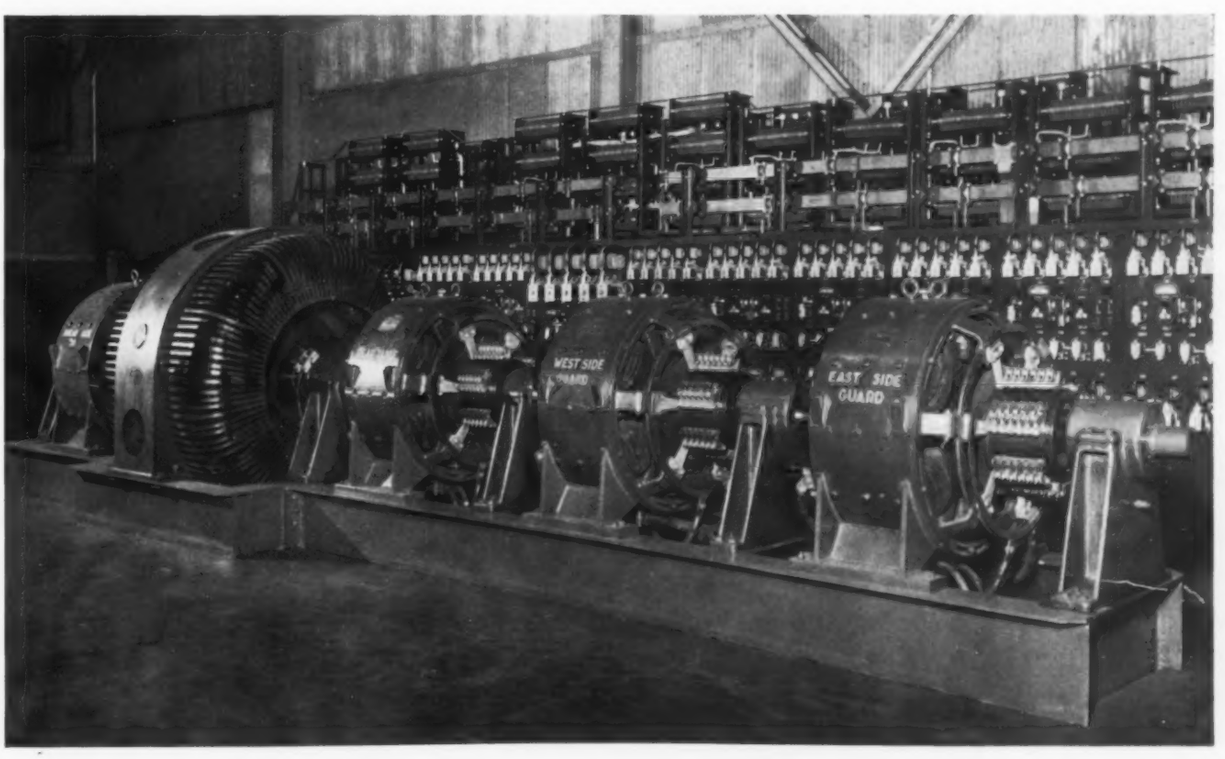
The foreman uses a shop order requisition for all electrical changes made to apparatus in his department, giving the driven unit, armature and frame numbers, days in service, to whom assigned and reason for the change. This information in conjunction with condition information obtained at the shop is the basis for hard service, normal service and light service designations for the unit.

He has a yearly list of all special units throughout the plant which are included in our must-be-done-regular category. This list serves as a record of work done and as a schedule when it is to be next done. It is also used by the foreman to show a departmental superintendent that his particular department is not the only one doing this type of work during the year.

He has been instructed that with the exception of the large main drive units only complete motor changes are to be made. We believe, in general, an armature failure indicates a thorough inspection of the other parts of the motor frame is necessary.

He has a list of apparatus which due to its size must be taken care of on location. The number and occupation of the different craftsmen required per turn, and the work they will accomplish is worked out for each eight hour turn, for each unit that is to be serviced on location. By consulting this list he is able to advise his departmental superintendent just how much time is required and the approximate cost of each maintenance job.

Each unit of apparatus has its individual pieces matched, marked, and so numbered that there will be



no time lost during assembly in the finding and fitting of parts. Necessary special tools, slings of proper size and length for correct lifting, spreader beams, blocks, etc., along with any special plant instructions are kept in a location convenient to the unit for which they have been prepared.

Each foreman accompanied by two other electrical department foremen make semi-annual inspections of apparatus in each department, observing not only electrical conditions but conditions which would effect electrical performance. By this method each department receives a complete check and each foreman is given an opportunity to check at least two other departments, keeping himself posted not only in his own department but familiarizing himself with the other fellow's apparatus and methods.

Our foremen are also included as members of the general plant cleanup and sanitary committee, so they eventually have an opportunity of completely inspecting each department in the entire plant.

Each foreman keeps a written running report of unusual happenings in his department which in turn is sent to the electrical department superintendent. This keeps the electrical department superintendent in touch with all unusual activities throughout the entire plant and gets away from those lengthy, so-called conferences so commonly the seat of rest and not accomplishment.

The foreman's yearly report of changes and improvemade in his division during the year in our endeavor to lower cost and improve operations is indeed interesting. He takes great pride in this report. It is in a way a record of the interest taken in his division, not only by the foreman but by the workmen. It also includes all cleaning and varnishing jobs he recommended and those he was able to complete.

He also reports each month the hours worked by each man in his group, tonnage produced in his department, and delays, indicating who received the delay and to whom the apparatus was or had been assigned. He reports each morning to a central office the delays and changes in apparatus in his department so that by 8:00 o'clock the electrical department superintendent has a record of all that effected departmental operation during the last twenty-four hours, enabling him to call for cleaning and varnishing jobs in order to maintain a full schedule of work ahead of the shop.

The foreman is not expected to spend all his time in preparing estimates, budgets, bogies or whatever you call them, as to the approximate cost of doing maintenance work, but he is expected to be out and actively doing this work. After all, what is the difference if the work does cost as much as, more or less than the estimate if you have warded off a long production delay and saved thousands of dollars in repairs by a relatively small sum in maintenance.

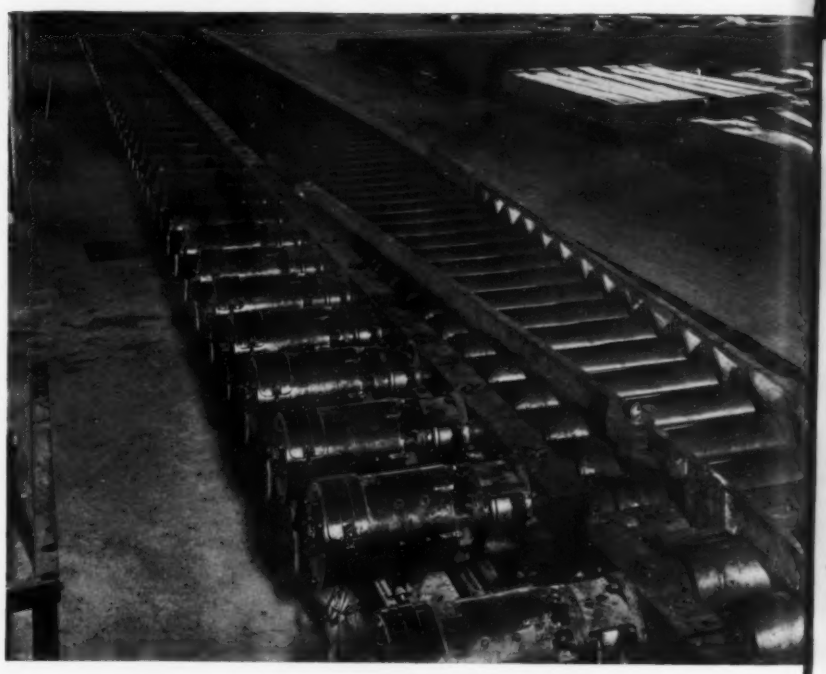
Efficiency engineers, in general, cannot plan our schedule of work on main drive units, although they are of great assistance on routine shop work on auxiliary equipment. Each time a main drive unit is disassembled and worked upon it seems to be an individual job due to factors beyond our control encountered during the maintenance work.

The departmental superintendent must abide by your judgment and schedules, and must not be in a position to say "No," when planned maintenance work is due.

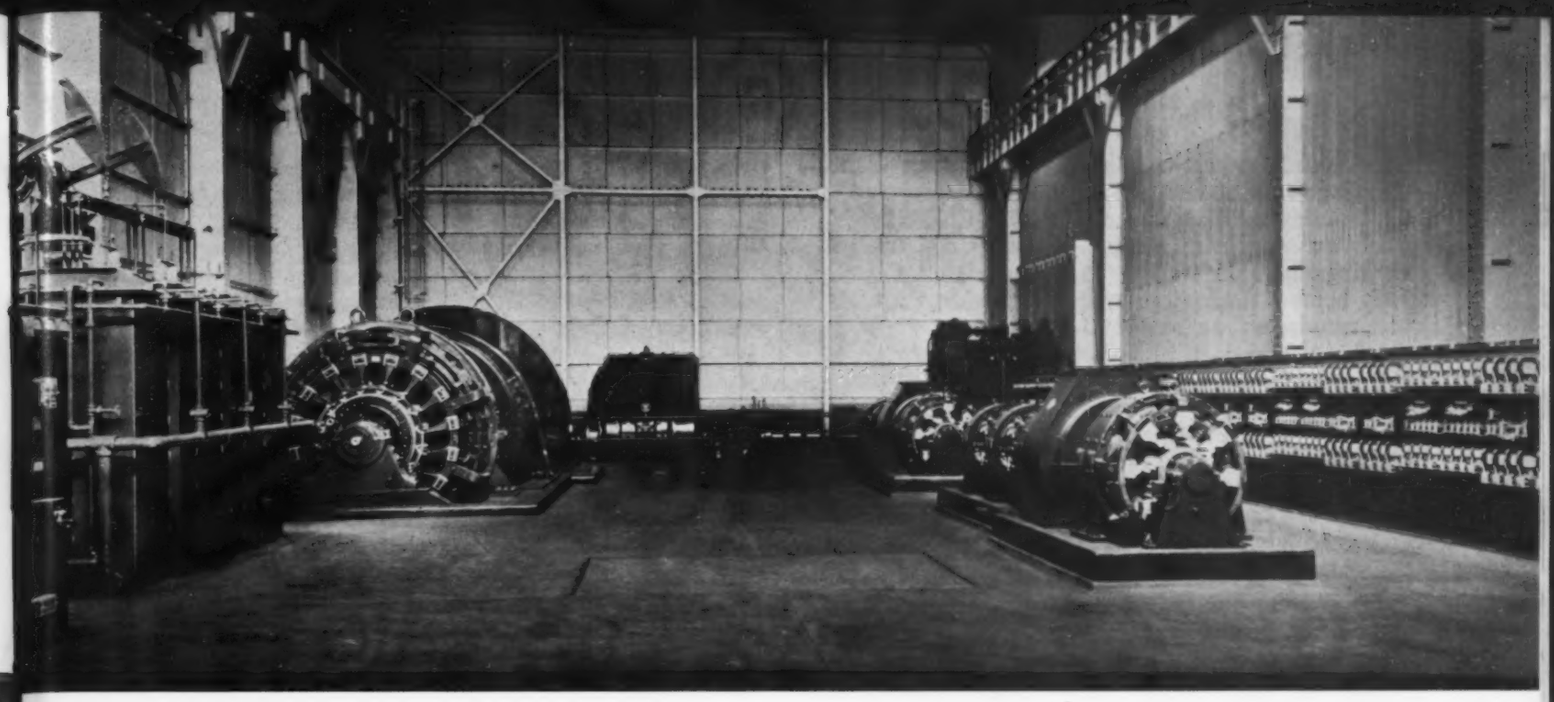
The foreman, in our opinion, should handle electrical maintenance and leave the scheduling and handling of cranemen, tractor operators and other such workmen o the operating department.

In order to carry on such a program you must necessarily have a management that recognizes results obtained and insists upon following schedules outlined, not only in the years when business is good but also in the years when business is bad. For, contrary to our usual teachings, maintenance work must be carried on more intensively in the years when business is bad, for it is then you prepare your apparatus for continuous trouble free service during the periods when business is good.

We consider our most important maintenance problem to be the one of safety. We do not intend to have any of our employes injured in the performance of



their duties, whether it be maintenance or repair work. So we have and enforce rigid rules and regulations. Frequent safety and instructive meetings are held. On many jobs each group of workmen have one of their fellow workmen appointed as a safety observer, who during the performance of his duties observes other men in their duties and will put a stop to any practice which might be considered unsafe. All men are furnished with necessary safety equipment, such as goggles, locks equipped with tags bearing the names and check numbers, safety belts and different types of respirators depending upon the duties to be performed. Frequent inspections are made of their tools by their foreman in order to check that the man keeps his tools in first class condition. They also receive first aid and gas mask instructions so they will be able to render emergency first aid to anyone unfortunate enough to be injured or accidently gassed. Our loss time injuries are exceptionally low. This is especially significant since the rules in our plant designate a lost time injury as meaning, that even though a man may return to work, if he has received a fractured bone, or is unable to perform the



duties he did before being injured, it constitutes a lost time injury.

Spare parts in a maintenance system require exceptional care, not only in handling but also in storage so they will be in serviceable condition when required. We have equipped all our remaining spare armatures with protective drum type covers which completely cover the armature and bearings, being a close fit at the shaft outside the bearings. These drums are larger in diameter than the armature so that the support for the armature is at each end of the drum where the shaft passes through the drum head. Motors are likewise protected against foreign material and damage. Roll train motor spare armatures are completely enclosed with a close fitting tarpaulin which has received a fire proofing treatment.

In the main electrical shop we have the necessary instruments, tools and personnel for handling our maintenance and repair work, so in general, we prefer all overhauling work to be sent to this shop. That is, we do not approve of the electrical man in the mill changing fields in motors, working on armatures or doing other work pertaining to motors. Their shop in the mills is not equipped for that type of work. They are better suited for control, brake shoes, resistance rebuilds and emergency jobs. We much prefer these men to maintain the control apparatus in excellent condition and make frequent inspections to keep accurate account of the condition of the apparatus which should, in our opinion, receive shop overhauling.

All electrical apparatus sent to this shop is dismantled, receives a thorough cleaning, testing, varnishing and then a running test before being sent back to the department for service. We believe in removing all fields from the motor when it is sent to the shop. They are also tested, put in first class condition, then dipped, varnished, and baked. Armatures are dipped in varnish, being completely submerged and then baked, sometimes receiving several dips and bakes before we consider them satisfactory for service. All apparatus receiving shop service gets this same, careful inspection and overhauling, for it is here where we are able to do the most good.

Each of the motor frames and armatures bears an Inland Steel Company number and a record card showing their service is maintained at the main shop. These record cards in the planning of our system were studied and formed a source of information which indicated changes in motor sizes or types. This has greatly improved the length of service we have obtained from motors. It also enables us to keep track of armature and motor frames which do not stand up under service. As an example, some mill type motor frames would come into the shop in an oily condition. Others of the same type and size would come into the shop perfectly dry. On investigation we found that some of the oil wipers on the armature shafts were actually running in the oil in the bearing reservoir. This was discovered by running an armature in one of these bad acting frames with the top half of the frame not over the armature. After we discovered what was wrong it was an easy matter to correct this fault by simply installing an internal overflow pipe of the proper height to prevent the oil in the bearing reservoir from reaching the oil wiper when the oil level indicator was not in the proper position.

Just as the management deems it advisable to appoint a departmental superintendent and make him responsible for the department under his jurisdiction, so have we found it advisable to make each field man responsible for a certain group of electrical apparatus in the department in which he works. All educational information relative to installed apparatus in that department is available for his inspection and study. The workman cannot be too familiar with the manufacturers' standards when taking care of that apparatus. This assignment does not relieve him or the other electrical men in the department from answering calls or doing emergency work on any of the apparatus in the department but it does give them a fixed responsibility for a

certain, definite part of the electrical apparatus and they do go over this assigned apparatus more thoroughly on the turns on which they are working. This is particularly necessary since we have so many departments working continuously and have employees working only forty hours a week. Also under this method the night turn men have the same routine work to perform as do the day turn men. It also enables us to keep track of the grade of work the man does, so we are in a better position to judge the man best fitted for promotion when that opportunity arrives. Be just but firm with discipline for neglect of apparatus or rule infractions. Be equally just and more liberal with compliments, slaps on the back and a cheery word for the boys who do a good job. For one job well done leads to another one when the man is given credit for his good work.

The foremen and workmen must realize that cleanliness of apparatus is of vital importance. Motors and control should be kept clean, especially the internal electrical parts of motors. With the newer model, totally enclosed, fan cooled motors this is no problem. However, with the old style motors, of which we have many in service, blowing out, wiping and cleaning of windings and frames is the regular order of work. Totally enclosed steel cabinets form a good protection when a pulpit or control room cannot be used as protection for control equipment.

Electrical lifting magnets are rugged, heavy pieces of apparatus but keeping all bolts tight, as well as welding the outer ring to the case at several spots, has greatly relieved the shop of magnet work. Having a station where the magnet can be connected and left on a low current heating and soaking cycle is a big factor in relieving moisture failures. Not allowing the magnets to be stored or kept on the floor or soil but keeping them on blocks also prevents the moisture hazard.

Spring and fall seems to be the best season to do the work found necessary by the power department electrical foreman on his inspections of overhead feeders. Some work is usually done on each circuit during the maintenance season. The painting and conditioning of towers is carried on during the weather most suitable for this type of work.

Mill and general purpose auxiliary motors are of so many different types and operate under so many different conditions, such as open and enclosed, forced and natural ventilation, clean and dirty atmospheric conditions, high and low temperatures, severe and light duty cycles, simple and complicated driven apparatus, etc., that only operating experience gained on individual jobs will be of any value in maintenance work. We have some cases where six months service is considered the maximum, others a year is just about right and from thereon up to six or more years service is oft times satisfactory.

Magnetic control properly applied and maintained is a very big factor in reducing cost, both in control renewal parts as well as reduced maintenance on motors and driven apparatus. This reduced cost extends well over into the mechanical cost. In many cases mechanical men are advocating and pushing changes to electrical apparatus in order to reduce their cost, each time referring to some change we had previously made which was of great benefit to them.

Mechanical maintenance men, by attending to truck bearings, make the maintenance of feed rails for cranes a routine job, otherwise it develops into repair work very rapidly. We pay particular attention to retaining insulators between the rails and the crane runway girders, as well as the condition of support insulators. Provision is also made for expansion and contraction of the feed rails due to temperature changes.

Storage batteries are expensive and rapidly deteriorate unless particular attention is paid to duty cycling. All of our batteries are assigned a number and a clock card and each time the battery enters or leaves the charging room this card is placed into a stamp machine which prints the date and hour upon the record card. There is space allowed for entering the specific gravity as found by the attendant when the battery is received and when it is ready for service. We feel this card system has been the means of our receiving a great deal more service from storage batteries than the manufacturer generally guarantees.

Switchgear requires its share of planned maintenance. The operating crew, generally being thoroughly familiar with the apparatus in their particular location, takes care of this work quite satisfactorily.

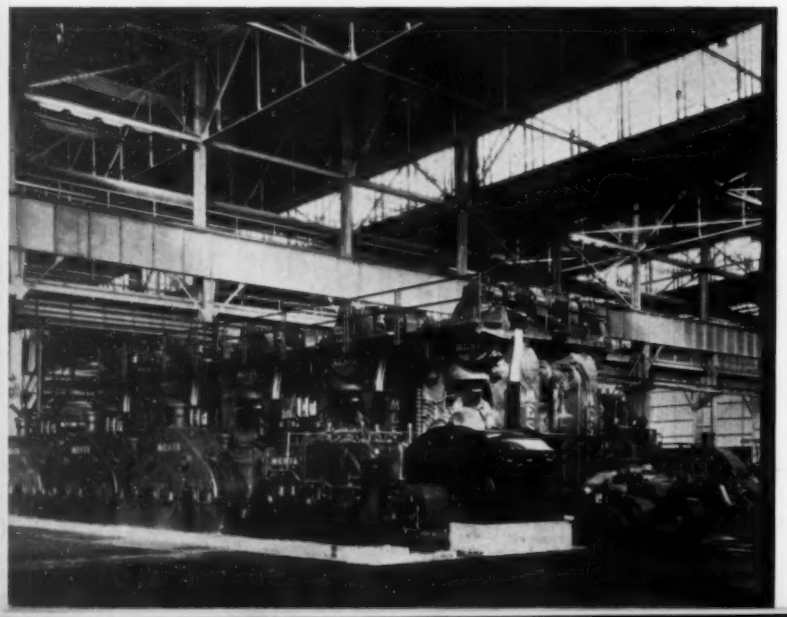
Plant lighting is one of the items hardest to handle and control. The departmental operating group really is the controlling factor in lighting cost. We must satisfy their demands for lighting in the department. A-c lighting seemingly gives a lower cost in lamp renewals and socket replacements.

Having resistance standards has greatly lowered our cost and makes it possible for the operating man to rebuild and maintain resistance frames in his department with a minimum number of spare parts.

Alignment of driver and driven apparatus must be closely watched if you are to protect expensive couplings and reduce or practically eliminate bearing troubles. It is advisable to have this checked thoroughly, not only when changes are made but occasionally during shutdown periods when the apparatus is not in service.

Foremen in their contacts with workmen explain their reasons for many changes, tests, etc., keeping the workmen interested in what we are doing. In that way he feels he is being consulted and that his views are requested and respected. The man actually taking care of the apparatus is generally a very good source of information in the elimination of trouble.

The electrical department passes upon or writes all specifications for electrical apparatus, not only in



changes to present apparatus but all new installations. The foreman concerned is consulted so as to enable him to check for duplicate apparatus wherever possible. This is a very big factor when spares are to be considered. It also keeps the foreman acquainted with all proposed additions or changes in his department.

Each task must be handled intelligently and there must be no hesitancy about making changes in your plans. Taking advantage of experience gained on each job is what eventually leads to a really successful plan.

We no longer find it necessary to work nights or week-ends in the shop as it is possible to do all shop work on the day turn, working five days a week with approximately one-half the number of shop men previously employed.

We no longer use the so-called mill motor crew and foreman. The foreman of each department is in charge of main drives, as well as auxiliary apparatus and now takes care of all this work with his regular crew.

We no longer have use for a large number of spare armatures and have used many of these spares in new frames to power added drives. This use of armatures has also made it possible to change motor sizes when production increased in an endeavor to hold down electrical cost.

We all realize there is a variance in opinion as to the differences in cost between the two systems, that is, planned maintenance and inspection and repair work. We are indeed fortunate in using the same system in keeping some of our records at present as we used before we became so active in trying to reduce and control cost by planned maintenance and inspection. Knowing how carefully you guard your own cost figures, I know you will not expect me to give to you our actual cost figures.

Since I will not give to you actual cost figures, a hypothetical case will be set up, the percentages being actually and exactly as our records indicate. This calls for us to assume a time just at the start of planned maintenance and inspection in our plant and compare it with a time several years later. Installed motors in operation are up 400 per cent and though some are on runout tables and similar drives where the horsepower is relatively low (two to five horsepower), others are on cranes, main drives, screwdowns and like installations. It is all apparatus to take care of and maintain.

For ease of figuring and presentation the previous year's planned maintenance and inspection will be considered as one hundred and comparative year figures plus and minus, thus:

	Then	Now
Motors	100	400
Shop labor cost	100	31
Shop labor hours	100	28
Material cost (plant)	100	48
Delays	100	37
Energy consumption	100	195
Rolled product shipped	100	139

If you were to analyze the information given it would be broken down as follows: The increase in the number of connected motors has been brought about by the building of additional blast furnaces, open hearth furnaces, hot and cold strip mills, tin mills, blooming mill and other finishing and processing equipment. The motors range in size from 10,000 hp continuous rating down to fractional horsepower ratings on smaller drives, the majority being in the size that normally comes to the electric shop for maintenance work.

Shop labor cost is lower because, in general, the major part of the work now being done in the shop is of such a routine nature, that is, cleaning and varnishing, not rewinding or rebuilding, so that lower rate men are able to handle it successfully. In the top or higher pay brackets, alone, our previous ratio of men to the present ratio is 100 to 37. All other occupations have also taken a downward trend with the exception of the lower bracket help.

Shop labor hours have dropped from ten hours a day, fourteen out of fifteen days to eight hours a day, forty hours per week. Also the number of craftsmen has been reduced. Some of this can best be explained by the following actual hours needed on different jobs done in the shop. These have been picked at random from our records.

	Hp	Repairs	Maintenance
Mill type armatures	15	22.2	8.1
	40	28.8	10.3
	75	49.0	14.0
	100	58.0	12.0
Mill type armatures, frames or both	30	72.0	16.0
	37½	73.4	22.0
	45	131.0	31.0
	100	164.0	30.0
	275	265.0	50.0
A-c	7½	42.0	6.0

Material cost figures are for the entire plant including the shop. We still use parent manufacturers' renewal parts providing they (the parent manufacturer) will give to us renewal parts that we believe are right for our service. In other words, if we decide, not because we think or believe we are designers, that a change is desirable to the design of renewal parts for original

apparatus and the parent manufacturer agrees with us and furnishes the redesigned parts, then he continues to receive this type of business from us. Otherwise, we enter the open market for these redesigned parts. As in the case of shop hours we are best able to explain some of the reduction by figures picked at random from our records. This group of figures includes labor, as well as material, for the task of separating the two in our opinion does not justify the extra time required. After all, these figures give to you just an idea of the possible difference in cost under the two different systems.

	Hp	Repairs	Maintenance
Mill type armatures	15	$ 85.00	$13.00
	40	173.00	17.00
	75	212.00	18.00
	100	255.00	17.00
A-c	5	99.00	24.00
Mill type armatures, frames or both	30	138.00	17.00
	37½	169.00	19.00
	45	206.00	22.00
	100	164.00	32.00
	275	696.00	47.00
A-c	7½	63.00	7.00

12,500 kva generator	$ 66.00
1,000 kw generator	102.00
800 hp, a-c motor	19.00
1,000 kw rotary converter	67.00
7000 hp bloomer motor	300.00
3,500 hp hot strip finishing motor	187.00
2,500 kw hot strip generator	180.00

Delays are the total for the entire plant, starting at and including unloading at the ore docks. New men unfamiliar with apparatus have some influence on delays, but, of course, the big single factor is the eliminating of as many breakdown changes as possible.

We will agree with you that all we have spoken about so far is not entirely due to planned maintenance. The one hundred and one changes in shop practice and methods have had their results felt throughout the entire division, but we must give planned maintenance credit for getting this apparatus into the shop before failures had occured. It was not until this had taken place that intelligence and ingenuity could combine in an endeavor to apply preventive methods and materials in avoiding failures.

In conclusion, it might be said that systematic inspection and maintenance of steel plant electrical equipment will assist you in maintaining a maximum, intermediate or low production rate with a minimum number of delays, lower labor and material cost and a far better satisfied group of employees.

DISCUSSION

PRESENTED BY

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J. J. BOOTH, Assistant Superintendent Maintenance, Duquesne Works, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

F. S. WHITE: Mr. Perry has covered the subject of systematic inspection and maintenance of steel plant electrical equipment in such a thorough manner that he simply leaves me, literally speaking, without wind for my sails. Having been associated with a large manufacturing company for many years in the capacity of service engineer, very naturally I view the maintenance and rehabilitation problem through the eyes of one who believes that it is sound economy to carry on hand (not on order) an ample supply of standard renewal parts made by the original manufacturer of the equipment.

How many of us would personally purchase something for which we could not get renewal parts and service on short notice, or from a concern which was not reliable and which is here today but gone tomorrow? None of us would buy an automobile, electric range, washing machine, or any other household appliance unless we felt sure of dependable service; and by the same token, the equipment which you are operating is correspondingly important to your management.

Obviously the manufacturer cannot, and does not, carry in his stock renewal parts for all of the equipment which he has manufactured back through the decades, but he does carry on hand, ready for instant use, the information from which to duplicate any parts required. You will appreciate, however, even with this information at hand and all the facilities for producing these parts in the shortest possible time, that this time is interminable when your plant is shut down awaiting the arrival of a part which should have been on the shelf of your store-room.

We are now entering the crucial period when even renewal parts are going to be desperately hard to obtain, and it therefore behooves each individual respon-

sible for the proper maintenance of equipment to take stock at once and provide an adequate supply of parts to assure continuous operation of your plant through this national emergency.

I imagine I can hear some of you saying that this entails a large expense and that many of these parts may stay on our shelves for years before they are used — and they may. There have been cases where managers have provided thousands of dollars for repair parts as an insurance against breakdown, and over a period of years still have some of the original purchases in stock. They consider that they have made an unsound investment. However, these same managers pay fire insurance premiums, compensation insurance, and insurance premiums of every description, and have never had to pay a liability; but, nevertheless, they would not feel safe if they did not pay such premiums and carry such insurance. They feel that this is good business.

Surely the same management which pays the salaries and wages of efficient master mechanics, electrical engineers, maintenance operators, and maintenance inspectors will also provide the necessary money for carrying the proper stock of parts for equipment vital in the flow of uninterrupted production.

T. E. HUGHES: Mr. Perry's idea of preventative maintenance is well taken, in that his actual costs are considerably less than repair costs that result when equipment is left in service too long.

Referring to the methods and procedure used by Mr. Perry in his preventative maintenance program, I would like to ask the following questions:

How do you determine when a given motor should come to the shop and, likewise, how are mill drive units and other large units that must be serviced in location scheduled? Do you maintain a record of dielectric strength, by use of such instruments as the megohm bridge, past performance, or do you schedule the work on some sort of life-expectancy records?

W. A. PERRY: In general, we figure the service work on drives in the mills by the days in service schedule. We do not make a regular practice of testing the apparatus and then trying to schedule our maintenance work when the dielectric strength is declining. We have found that about eighteen months of service on main drives warrants a cleaning and varnishing job.

T. E. HUGHES: Do you pay your shop or field forces on an incentive basis? If so, was the incentive plan responsible for the cost reductions you have referred to?

W. A. PERRY: We have an incentive plan in the mill itself, and also an incentive plan in the shop.

T. E. HUGHES: Was that established before or after this period?

W. A. PERRY: The incentive plan happened to be in force before the plant maintenance system went into effect.

T. E. HUGHES: There is one other point that has to do with expensive delay jobs over which your men have no control; that is, damage caused by carelessness. Your maintenance men may do a very good job and carelessness on the part of others may nullify it completely. Do you attempt to control this condition?

W. A. PERRY: We have a so-called damage equipment report and when the electrical or mechanical maintenance man in the mill reports to the foreman that a delay or damage was caused by abuse or carelessness, the foreman fills in one of these reports. A copy of the report is retained by the electrical or mechanical foreman; one copy goes to the master mechanic or electrical superintendent; one copy goes to the departmental superintendent; and the original is sent to the office of the plant general superintendent. Usually that is all that is required to prevent a recurrence of the type of trouble that necessitates the issuing of a damage equipment report.

E. C. BRANDT: There is one phase of this maintenance and inspection job on which Mr. Perry has not dwelt to any great extent, and that is the possibility of having a maintenance equalization accrued fund for this purpose. Therefore, I would like to offer a maintenance equalization program for this Association's consideration.

It is the purpose of the maintenance equalization program to standardize, over a period of say 10 years, the amount of extraordinary maintenance expense budgeted in the indirect manufacturing expense rates and to make charges to current operations consistent with the productive activity for the period. The maintenance equalization program applies to extraordinary repairs to buildings and structures, and the complete overhauling and rehabilitation of durable equipment.

At each works, accrual rates shall be determined by listing specific items of expense to be included in the program. The period of accrual of recurrence for each individual item shall be determined. The normal monthly accrual for each item shall be obtained by dividing the amount of expense estimated for that item by the accrual period in months. The total normal monthly accrual shall be computed by summarizing the accruals for the individual items

Accrual for maintenance equalization shall be budgeted in indirect manufacturing expense identified to a special account, "Provision for Maintenance Equalization" and included in indirect manufacturing expense.

Where maintenance of buildings and structures is supervised by a central maintenance department, the items covered by this account shall be budgeted and identified as "General Plant Expense." In all other cases the accrual for buildings and structures shall be budgeted as a divisional or departmental expense as the case may be.

The accrual for complete overhaul and rehabilitation of durable equipment shall be budgeted in plant, divisional or departmental expense depending upon the method of budgetary control used.

Stabilization and control of finance by management through maintenance equalization budgets or equalizing reserve accounts can provide for rehabilitation and maintenance during slack periods. Annual maintenance appropriations are just as necessary and should be provided the same as capital goods expenditures. If nationally adopted this maintenance and rehabilitation method will go far toward leveling out depression periods.

W. A. PERRY: In our plant we make no effort to set aside any fixed sum of money against maintenance. When a machine is started, whether it be a large or small unit, whether business is good or bad, when the days we have set up on the schedule have gone by, we

take that piece of equipment out of operation and give it an overhauling. When the management sees a record like this, where shop labor cost is only 31, shop labor hours down to 28, and total plant down to 48, there is not likely to be an argument. When the 365 days or whatever the schedule is, have rolled around, the men take out the equipment and into the shop it goes.

C. L. MCGRANAHAN: If I am correctly informed, Irvin Works operates with a minimum number of spares. Would you mind telling us, Mr. Krieger, how that is accomplished?

A. M. KRIEGER: The fact that each departmental superintendent has been made responsible for the maintenance of his equipment has had a great deal to do with the minimizing of our spares account.

In order to show a good overall performance, the operating superintendent must be concerned over the treatment accorded his equipment and naturally, less abuse results, eliminating to a great extent the necessity for carrying numerous spares.

Preventative maintenance, of course, is of equal importance and our plan of thorough, periodic inspection is continually revealing conditions requiring attention before breakdown and replacement by a spare is necessary.

I would like to ask Mr. Perry on what his incentive plan is based — production, job estimate or what?

W. A. PERRY: The alloted hours to do a job, and those hours are worked out by efficiency engineers.

A. M. KRIEGER: Do you pay an incentive on each job?

W. A. PERRY: There is not an incentive rate on a job until it has a background showing whether it is right or wrong; then we have a limit.

A. M. KRIEGER: Are all shop men on an incentive plan?

W. A. PERRY: Yes. Every man, with the exception of the sweeper, has a chance to get on some job during the day that has an incentive.

W. A. SMILEY: The only thing that occurs to me is more or less an echo of what has been said previously, and that is, how will you spend your money when you are about broke? It is very nice if you have a management that can provide funds over a depression, say, like the one we have so recently enjoyed; but it may not always be possible. Then again if we set up a maintenance account, as has been suggested, there most certainly will be nothing to prevent the management from applying that account to emergency conditions brought on by the depression. So that in any case, maintenance is the goat that will suffer. Where is the home-owner who gives his house a much needed coat of paint when he has no food for his table?

W. A. PERRY: We do not approve of a maintenance account for maintenance work. We practice what we preach — doing the work when the pre-determined time has arrived.

I agree with Mr. Smiley that a fund built up for one purpose might quite easily be used for some other purpose at a time when company funds are low. As I have said before, you must necessarily have a management that recognizes results and insists on following the program outlined, not only in years when business is good but also when business is bad. Fortunately we have that management.

A. W. MCAULY: Was this system tried all over the plant, or was it first tried in a small department?

W. A. PERRY: We called a meeting and had the foremen in the electrical division come to the shop and express their views. The principal job seemed to be the main drive units and this was our starting point. We shut them down as quickly as possible, gave them a thorough cleaning and varnishing. We then started working on the auxiliary motors taking a few from each department.

A. W. MCAULY: Did you find for a short time after the system was inaugurated that your costs increased somewhat; or was there an immediate reduction?

W. A. PERRY: The costs started to go down shortly after the system was inaugurated, especially shop and material costs.

A. W. MCAULY: Based on your experience, it is your opinion that no plant can afford not to adopt this system?

W. A. PERRY: Since we are operating under this system it is only natural that I believe it would be advantageous for any plant to adopt a similar system. You can materially reduce your inventory of spares and do not have a sense of insecurity about not being properly protected. At the moment it is more or less the custom for everyone to buy more spares than they previously thought necessary. This of course is brought about by the feeling that somebody else may get the parts that eventually we will need and not have.

On the subject of vee ring grounds, we believe we have that licked. We do not believe that the trouble develops as a ground but that it develops as a short between the commutator bars and burns through the mica vee ring and is then called a grounded vee ring. We have found many such cases in the inception stages and feel quite sure that we are on the right track when we endeavor to prevent grounded vee rings by preventative methods on the end of the commutators.

J. S. MURRAY: I would like to ask Mr. Perry how frequently he cleans and varnishes totally enclosed main roll units which are ventilated by fans with filters or air washers.

W. A. PERRY: If you take them about apart every eighteen months and give them a thorough cleaning and varnishing, you can get away from serious breakdowns.

J. S. MURRAY: How do you clean the motors on main roll drives? It is my observation that if a motor is not cleaned one hundred per cent you are going to varnish in a certain amount of dirt in the windings. I consider that particularly important in 600 volt direct current motors, especially where you have two commutators and at best a difficult cleaning job. And there is a question in all of our minds whether we may not do more damage in sealing in moisture and dirt by covering it with varnish, or just clean and let it go at that.

W. A. PERRY: If the apparatus is located in a fairly clean department, the generous use of compressed air, wiping cloths, and brushes is all that is required to clean the parts before they are varnished. Possibly once in a few dozen times we run across a piece of apparatus that requires the use of a solution of tetrachloride and

(*Please turn to page 127*)

ENGINEERING for Increased PRODUCTION in the Steel Industry

. . . . the capacity of many of the older electric drives can be stepped up to keep up with increased production from existing equipment . . . .

By R. H. Wright

STEEL MILL ENGINEER

Westinghouse Electric & Manufacturing Company

EAST PITTSBURGH, PENNSYLVANIA

Presented before A. I. S. E. PITTSBURGH DISTRICT SECTION, April 13th, 1942

▲ AMERICAN steel plants are equipped as they never were before. New equipment installed in the last few years has been so fast and so powerful that it was seldom necessary to operate any unit at capacity in order to take care of normal peace time needs. Now, in the present emergency steel makers are discovering, perhaps for the first time, the possibilities and the limitations of their plants. Not only is it necessary to operate equipment at rated capacity but continually to find ways of increasing capacity. Steel plant engineers have exhibited great ingenuity in this activity.

Some of the ways now being used to increase steel production are:

1. Conversion of existing equipment. The use of continuous strip mills for producing heavy plate is a typical example.
2. Rebuilding old equipment for greater capacity and greater reliability.
3. Replacement of unreliable mill drives, both steam and electric, to reduce delays.
4. Increasing the capacity of existing mill drives where such increase will raise the output.
5. Utilization of existing idle equipment.
6. Reducing lost motion and generally speeding up production of existing equipment by careful engineering analysis of equipment and its operation.
7. Expansion. New construction goes on almost continuously, the rate of course being regulated by business conditions.

Many existing mills were installed to roll more than one product. This usually makes their conversion to one product easy. For example, some rod mills are designed to roll merchant bar and with little or no change can roll either product exclusively. A number of continuous wide strip mills were laid out to roll a certain amount of plate and with suitable finishing capacity can roll plate exclusively. Other strip mills can be converted for

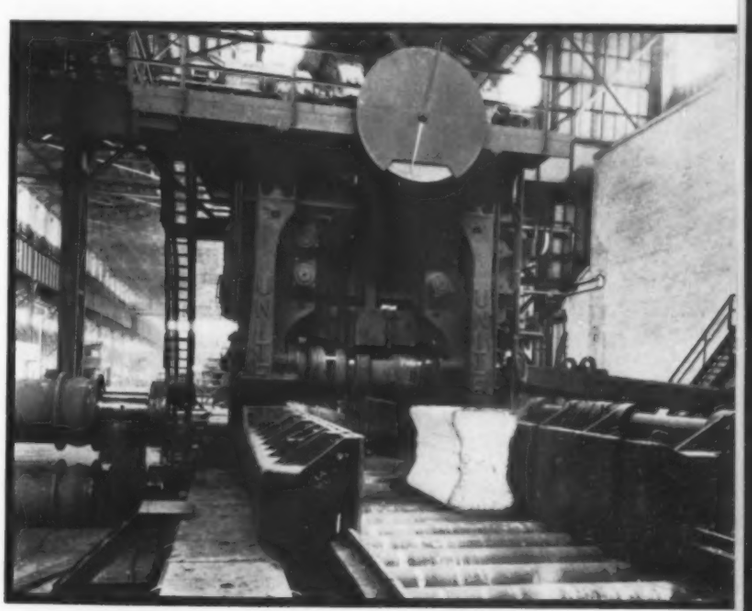


Figure 1 — Time studies of mill equipment which operates on a frequently repeated cycle often show how production can be increased.

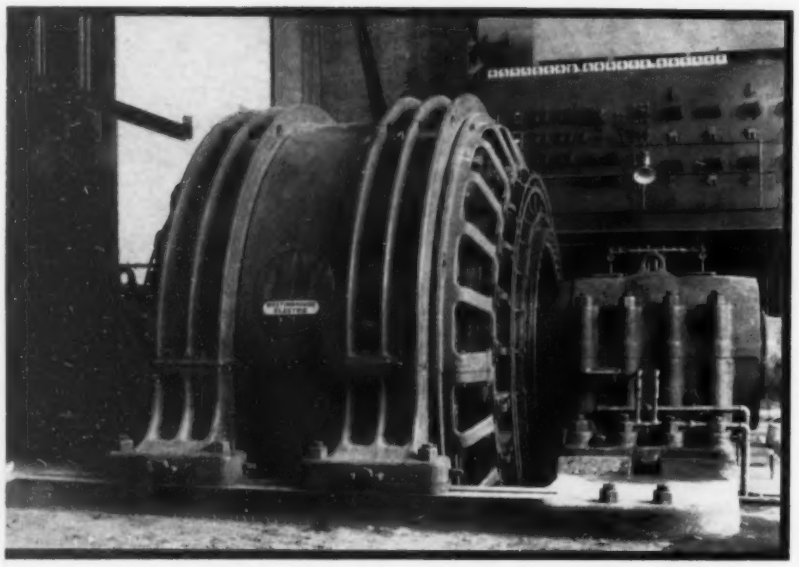


Figure 2 — By rebuilding the armature of old reversing motors and installing new interpoles the continuous capacity may be increased as much as 40 per cent.

production of plate. Such a conversion will usually involve the following changes:

1. Installation of roll tables between finishing stands to replace the chutes and loopers used when rolling strip.
2. Sectionalizing a part of the runout table to operate in conjunction with a plate transfer.
3. Installation of a plate transfer.
4. Installation of plate shears, levelers and other plate handling equipment.

The electrical equipment to be used in a typical case is as follows: Two motor driven rollers will be installed between each pair of finishing stands. These rollers will each be driven by a totally enclosed non-ventilated general purpose d-c motor geared for the proper speed. Each pair of motors will be supplied from a separate variable voltage generator. Each generator will have two sources of excitation — a pilot exciter on the preceding mill stand and a separate master exciter. The part of the runout table which carries the finished plate to the transfer is divided into two sections. The original a-c variable frequency motors in these two sections will be replaced with d-c motors. The motors in each section will be supplied from a d-c variable voltage generator. When heavy plate is being finished in the roughing train the tables between finishing stands and the two sections of runout table will be operated at about the speed of the roughing stand in which the last pass is made. All the table generators will be excited from a common source for this condition. When light plate or strip is being finished in the finishing train all tables will run at approximately the speed of the metal. That is, the tables preceding the stand used as a finisher each run at the speed of the adjacent stand and the tables following the finisher all run at the delivery speed of the metal. For this condition the generators for the tables behind the finisher will be excited from the pilot generators on the adjacent stands. All tables following the finisher run at the same speed. For this condition all generators for tables following the finisher will be excited from a common master exciter.

Under present conditions it is necessary to push production on equipment which is twenty-five to thirty years old and which under normal conditions would not be expected to carry heavy loads. Such installations were made at a time when diversity of product rather than high total output was desired. For example, a blooming mill installed in 1918 usually was designed to roll 4 in. x 4 in. billets and blooms up to 8 in. x 8 in. and a small tonnage of narrow slabs, all from small ingots. It was not necessary for the main and auxiliary drives to have high continuous capacity to handle the tonnage which could be produced under such conditions.

A blooming mill of that time usually was driven either by a single armature motor of about 2500 hp continuous capacity or by a double armature motor of

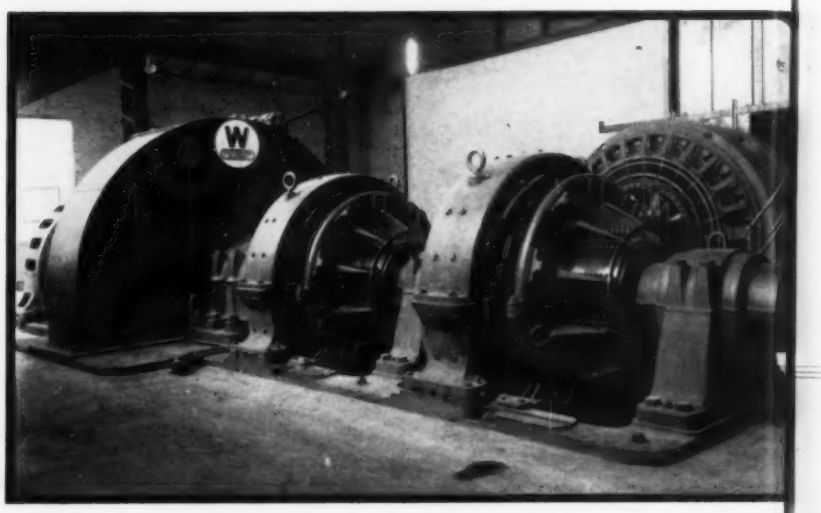


Figure 3 — The continuous capacity of old flywheel sets may be increased by replacing the driving motor or the generators or both.

about 5000 hp capacity. As the development of rolling mill drives proceeded it became possible to obtain 3500 continuous horsepower in a single armature with the same dimensions as the old 2500 hp design. This gave 7000 hp for a double armature machine. As spare armatures were ordered they were built with the 3500 hp winding. This 40 per cent increase in capacity was obtained by using deeper slots and larger copper straps in the winding. To utilize completely this increase in armature capacity, it is necessary to provide interpoles which will provide more flux in the commutating zone. Old motors can be rebuilt to take advantage of this 40 per cent increase in capacity. This is done by repunching the old armature laminations or using new laminations, rewinding the armature with heavier coils, and by installing new interpoles.

Where a number of similar reversing equipments of old design are operated by one company, it is possible to improve reliability by purchase of a spare motor armature designed to fit in any one of several places. As an example, a new double armature recently built for one of the older reversing equipments was designed so that it would fit in any one of four locations. As soon

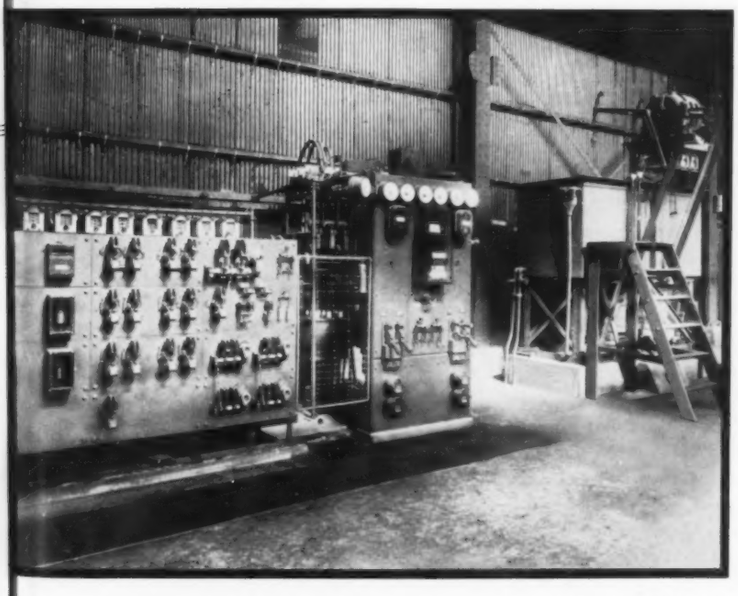
as the new armature was completed it was installed in one location and the old armature was rebuilt so that it also would fit in the same four locations, thus providing an up-to-date spare. The reliability of the oldest installation was thus increased and delays due to possible burnouts at the other three locations will be minimized.

Some of the older reversing equipments have generators which with minor modifications will carry a considerable increase in load. In other cases it is necessary to replace the generators with larger machines to secure an increase in capacity. Space is usually available on the old bedplate for such a change. On many of the old flywheel sets the induction motor will not carry the increased average input when there is a material increase in load on the d-c end of the set. The original motor can be replaced with a larger machine where such a change is desirable. Where a number of reversing equipments are being operated in one plant, it is possible to make such changes gradually by shifting of equipment. A number of changes of this nature have been made.

The operation of the field control of a reversing equipment has a considerable influence on the ease with which the reversing motor and generators do their work. If an old control is replaced with control of the latest design the d-c machines will operate with greater ease and less maintenance and there will be less control maintenance.

The reversing equipment has been taken as an example of how capacity can be increased by rebuilding of equipment because such drives are made up of several types of electrical apparatus. The same procedure can often be applied to other forms of main drive equipment.

Figure 4 — Replacement of an old field control with new control of late design will reduce maintenance on a reversing equipment.



Mill auxiliaries are of course quite as important as the main drives. Their loads are in many cases as much affected by the production rate of the mill as are the loads on the main drives. Many auxiliaries drives in use today were installed before electric main roll drives were in common use. Where such drives become overloaded and cannot be replaced readily with larger equipment the best insurance against excessive delays is an adequate supply of renewal parts.

Improvements in insulation make it possible to increase the capacity of many of the old d-c auxiliary motors. As an example, the old Westinghouse 12-A motor can be rewound with new armature coils having a copper section 24 per cent greater than the original coils. Space for the greater section of copper is made available by the use of improved insulation. New armature coils with greater copper section also are available for frames 20 to 60 of the old Westinghouse MC line of motors. These coils have a copper section 12 to 29 per cent greater than the original coils.

Methods for replacing the original sleeve bearings with anti-friction bearings have been worked out for the old lines of mill motors and crane and hoist motors. This change will eliminate maintenance caused by the injurious effects of oil. Renewal parts which will give longer life for contacts and moving parts have been developed for a line of steel mill contactors. These examples have been given as being typical of the efforts of electrical manufacturers to meet the need for increased output from existing apparatus with reduced maintenance.

The ability to obtain increased electrical capacity in the same or smaller space often makes it possible to increase the output of a mill without disturbing the foundations or mechanical arrangement. For example, a 750 hp, 200/600 rpm, 600 volt d-c motor installed in 1928 as part of a rod mill becomes overloaded whenever the output of the mill is pushed above normal. This one motor limits the output of the mill and makes an operating hazard due to the overloads now being carried. Investigation showed that if this motor were provided with a new armature of later design the rating could be increased to 900 hp; the interpole and compensating windings having sufficient margin to carry the increased current. Further study showed that a complete new motor could be built which would fit into the available space. Such a motor would have a rating of 1200 hp. Thus by increasing the capacity of one motor the output of a mill with several drives could be increased with safety to all the equipment.

A reconstruction of this nature was actually carried out recently on a 5-stand cold strip mill. This mill was built originally for an average delivery speed of 1000 fpm. The original main drives consisted of five 800 hp, 600/1000 rpm, 600 volt motors supplied from two 1250 kw generators. After this equipment had been operating for a few years there was an urgent need for greater production. A study of the mill layout showed that new motors of 1500 hp capacity could be designed to go in the space occupied by the old 800 hp motors, and that the gearing could be changed to increase the delivery speed of the mill. Accordingly the gearing of all the stands and the reel was changed to give a normal delivery speed of 1650 fpm. Four of the 800 hp main motors were replaced with new motors rated at 1500 hp, 600/900 rpm. Additional d-c power was provided by using an old 2300 kw generator and an old synchronous

motor from another mill. These machines had not been operated to capacity in their original location and were replaced by smaller machines. Thus with a minimum of expense and delay the output of the cold mill was increased materially and unused capacity from another mill was put to useful service.

With the large amount of electrical equipment which has been installed and the changes in mill processes which are continually taking place, a certain amount of electrical equipment is continually being shifted about. In the past few years many motors have been moved. Motor generators have been dismantled and the machines used for other purposes. A certain amount of equipment is always idle as a result of such changes. Sometimes a little study will show how this idle equipment can be used to great advantage. For example, a 5000 hp, 75/150 rpm reversing equipment was installed in 1923 to drive a universal plate mill. After several years of operation the mill was dismantled and the electrical equipment went into storage. At another plant owned by the same company there was a steam driven blooming mill which had high operating cost and high maintenance cost. Due to the age of the engine it was becoming very unreliable. In looking about for a way to improve conditions the natural question was — why not use the reversing equipment from the other plant? At first thought this did not look feasible. The base speed of 75 rpm was higher than is ordinarily used on a blooming mill. However, a study of the mill showed that the rolls were smaller in diameter than normal. This made it desirable to have a base speed higher than the usual 50 rpm. The ingots were small and no wide sections requiring heavy torques were being rolled. Also it was found that by increasing the motor field current the base speed could be reduced to about 70 rpm and the maximum torque increased accordingly. It was decided to remove the engine and install the reversing equipment. The control was adjusted so that the reversing motor operates between 0 and 70 rpm. This equipment has been driving the mill for several years with very satisfactory results.

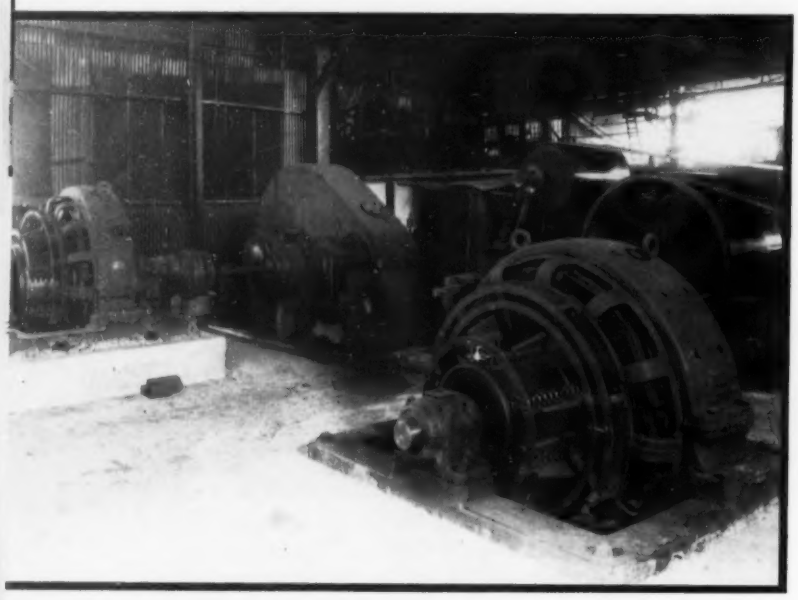


Figure 5 — When the load exceeds the capacity of an old adjustable speed d-c motor, a modern motor of greater capacity can be provided to fit the original foundation.

Figure 6 — A detailed study of a machine which must be started and stopped frequently and quickly may show how inertia can be reduced and operation speeded up.

In another instance a direct current marine motor which had been built to propel an oil tanker was used to replace an old engine on a three-high universal plate mill. The motor was reconditioned and a synchronous motor-generator and field control for the d-c machines were provided so that the motor could be used as an adjustable speed non-reversing drive. The operation of this equipment has been very satisfactory.

Time studies often give interesting and surprising results. This is particularly true in cases where there is a definite duty cycle which is repeated continuously, as in reversing mills. It is quite generally understood by steel mill engineers that metal is in the rolls of a reversing mill only about 30 to 40 per cent of the total time. Not all rollers appreciate this and they sometimes insist that they cannot increase production unless the power and speed of the main drive is increased. Yet practically every blooming mill or slabbing mill which holds high tonnage records operates at moderate speeds and high output is obtained by maintaining an even flow of steel through the mill and by keeping the intervals between passes at a minimum.

A number of years ago a test was made on a blooming mill which had excellent tonnage records. The operators felt that the high output of the mill was due to high operating speeds. On one schedule it was found that the average time per ingot was 81.2 seconds. Of this time the ingot was actually in the rolls 32.7 seconds. On reviewing the results of this test the operators felt that it did not show the best that could be done because the rolling speed was not as high as could be obtained. Later another test was made. For this test the average time per ingot was 72 seconds and the time was in the rolls was 23.7 seconds. Thus by increasing the average rolling speed 38 per cent the output was increased only 12.8 per cent. The total idle time between passes was

the same for both tests. This was because the mill was provided with special equipment which gave about the minimum time for manipulating the ingot and returning it to the rolls. The conclusion reached after these tests was that the high output of this mill was due chiefly to the excellent manipulation between passes.

A recent oscillograph test of a large reversing plate mill showed that steel could be kept in the rolls 35 per cent of the total rolling time. This is good practice for reversing mills in general but is not the best which can be obtained with a plate mill. No difficulty was encountered in maintaining production for peace time needs under such conditions. A study of the oscillograms showed that the best way to increase production was to reduce the idle time between passes. However, the oscillograms also showed that the pass intervals could not be reduced materially unless some way was found to speed up the screwdown. From a study of the mechanical details of the screwdown it was found that the mechanism had excessive inertia and that by a fairly simple change a large part of the inertia could be eliminated. This change will increase the output of the mill as a whole.

The advantage of variable voltage drive for many types of auxiliaries are quite well recognized. Among these advantages are faster operation and greater ease of control. In recent years variable voltage drives have been used freely in new installations for skip hoists, screwdowns, tables, shears, shearing lines, cleaning lines and other similar applications. A changeover to variable voltage drive will increase the speed of many existing auxiliaries and eliminate bottlenecks in mill output. A number of changes of this nature have been made.

Rail transportation has been speeded up by reducing the weight of rolling stock. This is particularly true of the electric street railways where a material reduction in dead weight has resulted in higher rates of acceleration and braking with consequent saving in overall running time. Steel plant equipment has been built primarily to withstand heavy shocks with weight as a secondary consideration. As in the case of the screwdown previously mentioned, excess weight in rotating parts may have a serious effect on the time required to complete a given duty cycle. Weight in parts which rotate at high speed adds flywheel effect which must be overcome each time the device is accelerated or brought to rest.

A typical example of the effect of weight in rotating apparatus is a high speed merchant mill with a flying shear which starts and stops for each cut. Just before a cut is made the blades of the shear must be accelerated to a speed slightly above the speed of the metal. The higher the speed at which the cut is made the higher must be the rate of acceleration. At high delivery speeds the shear blades and their gearing will have enough stored energy to make the cut without help from the motor. It may be possible to increase the delivery speed of the mill. However, it may not be possible to use higher mill speeds because inertia makes it impossible to accelerate the shear to the correct speed in the time available. By reducing the weight of the blades it will be possible to reduce the weight of the gears also since they carry only acceleration load. The shear can then be operated at higher speed and the whole mill can be speeded up.

PERRY *Discussion . .*

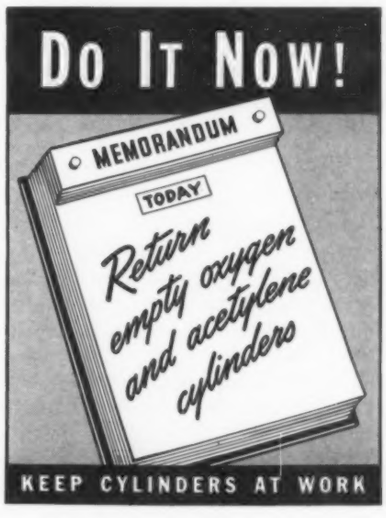
(*Continued from page 122*)

gasoline or some other mixture that will cut the oily deposit on the apparatus.

We heat all parts before they are varnished so that we get a thorough drying job and do not seal in any moisture. We re-heat again after the varnishing.

J. J. BOOTH: Mr. Perry has brought out many very excellent points relative to the general upkeep, maintenance and repair of electrical equipment, both main drive and auxiliary drive, in a modern steel mill. His recommendations relative to general maintenance and inspection of motors and the process of sending this equipment to the shop for general overhauling and repairs before breakdown in my opinion is an excellent procedure. I also happen to know that this particular procedure in Mr. Perry's plant is carried out very much to the letter. However, since he has illustrated to us how he schedules his motors for general inspection and shop repairs, the transfer of same to and from field and shop, the general repairs as carried out in the shop and the incentive plan which he uses for paying the men who repair this equipment, we would like to know what his procedure and methods are in handling the so-called paper work covering this general procedure. On the face of what has been given us, it would indicate that he must have a sizeable central planning group or special clerks to handle this bookkeeping

W. A. PERRY: I have a sheet indicating our cleaning and varnishing schedule for one year. This sheet has been in service for several years and it is simply a matter of referring to the last year's entry and then determining the units scheduled for cleaning and varnishing this year. Contrary to Mr. Booth's idea, this system does not require a large clerical force. We have in our main electric shop three young men who take care of all records and shop orders, and certainly they are not overworked. The foreman in the mill keeps his records and he too seems to have ample time to keep these records up to date.



Steel Mill LIGHTING *in* WARTIME

By J. P. Ditchman

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GENERAL ELECTRIC COMPANY

CLEVELAND, OHIO

Presented before
A. I. S. E. SPRING CONFERENCE
Hamilton, Ontario, May 11-12, 1942

. . . . plant lighting is considered from three standpoints: for vision, for plant protection, and for blackout, all essential considerations under present conditions . . . .

m THESE days production problems are uppermost in the mind of every manufacturer of war materials. To produce today to win the war tomorrow we must do it quickly and safely. Light can help. Better lighting can do much to facilitate seeing and thus increase production. It magnifies details. It can make objects with poor contrast stand out to better advantage. With better lighting one sees more quickly and more safely. Safety of the workman can scarcely be overemphasized, particularly when we consider that today industry is calling on older eys and inexperienced eyes to help keep the machines running. (Figure 1.)

It has been said that a skillful workman is one whose hands, mind, and eyes are properly coordinated. The first two items we cannot do much about in the way of immediately making them more useful to the job at hand, but the third item is one over which we have full control.

The human eye is a most willing and versatile worker. It can make adjustments to all sorts of lightin conditions from blackout to sunlight without complaint. No other human sense is capable of such a range of adjustment.

The first step in improving seeing is to have the eyes fitted properly with glasses if necessary. After that, seeing is largely a matter of plant conditions, involving such things (see American Recommended Practice of Industrial Lighting, approved by American Standards Association March 17, 1942) as the amount of light; placement of lighting equipment, machines and men; absence of direct and reflected glare; shadows; color, diffusion, and distribution of light, etc. Misapplication in these matters can cause real bottlenecks in our war production effort.

The first and probably the commonest of all lighting bottlenecks is dirt. Dorty lamps, dirty reflectors, dirty windows, may be cutting the illumination down 50 per cent—the easiest cure is a regular soap and water cleaning schedule.

Direct glare is probably the next most common cause. It is the old problem of too much light in the worker's eyes and too little on his work. Glare is to be found in almost every plant. It may be caused by a lighting unit that is too bright because the lamp and reflector do not match. It may be a row of bare lamps, or fixtures not providing the proper shielding. Or, it may be the glare of a supplementary unit not being properly used by some worker. The solution in most cases is obvious, namely, shielding the lamps properly and placing them properly with respect to the work or worker. In the case of daylight glare, the windows may be shaded or the working surface moved to put

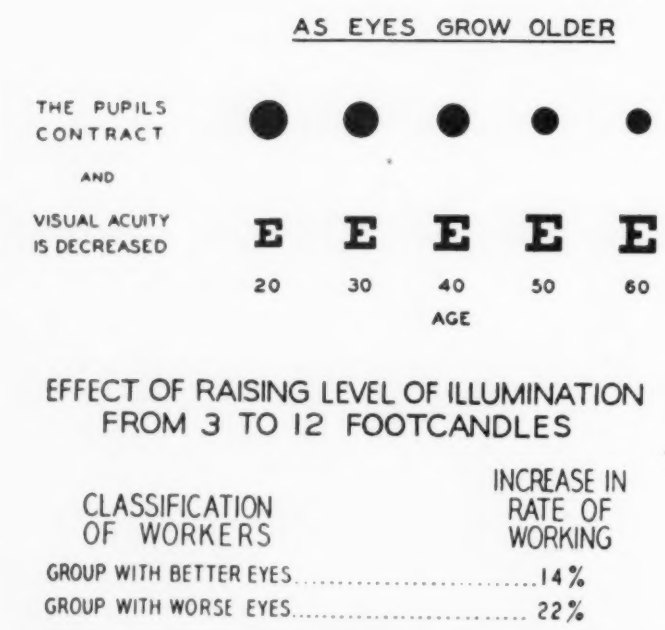

AS EYES GROW OLDER
THE PUPILS CONTRACT
AND
VISUAL ACUITY IS DECREASED
E E E E E
20 30 40 50 60
AGE
EFFECT OF RAISING LEVEL OF ILLUMINATION FROM 3 TO 12 FOOTCANDLES
CLASSIFICATION OF WORKERS
INCREASE IN RATE OF WORKING
GROUP WITH BETTER EYES..... 14%
GROUP WITH WORSE EYES..... 22%

Figure 1 — As the eyes grow older, physiological changes occur which impair vision. Higher levels of illumination serve to offset the handicap in seeing imposed by advancing age.

Rapid workers with normal vision are enabled to turn out more and better work when they are given better illumination. This also holds true for workers with sub-normal vision — but to a far greater extent.

the light on the work and not in the eyes of the worker.

Reflected glare is insidious and may be more objectionable than direct glare. It is the light that "bounces" from the work to the eyes. The solution may be a change from a concentrated light source to a large-area source, or to provide a higher illumination to offset the reflected image. In some cases only a change of direction of the work or light is all that is necessary to solve the difficulty.

Shadows. Every worker has experienced the effect of standing in his own light. Often an agglomeration of belts and machinery aggravates this trouble. The cuse usually is an adequate general lighting system. In some cases it is a large-area source, properly placed with respect to the machine or operation.

Contrast of dark walls or surroundings means frequent eye adjustments that are necessary when a worker looks up from his lighted work toward a dark area. The loss in time and the hazards introduced by such adjustments are a real bottleneck in industry. The solution is one of brightening up the surroundings, perhaps painting the machines in lighter colors or providing higher levels of illumination. This matter of contrast applies not only to the surroundings of the room but also to the sharp contrasts that may exist on the top of a desk if there are light papers against a dark desk top.

One should not overlook the bottleneck that is introduced through the 3-shift operation of plants which were designed for high utilization of daylight and do not have good artificial illumination. Better artificial illumination is the answer here. This will result in more men willing to work at night with a consequent better rate of night production.

There are numerous other bottlenecks in the hundreds of special inspection jobs: jobs requiring the proper application of light to produce shadows, jobs which require the use of special lighting to enable the operator to discriminate and match color, and jobs that require more light for faster seeing.

The protection of our war industries in all areas vital to their operation is of utmost importance. Knowing that darkness is a saboteur's greatest ally, it follows that light is industry's first line of defense.

Light, itself, is not sufficient. It may deter intruders from entering an area because it makes them visible if they do. But lighting should be used with other measures of protection, such as guards, fences, alarms, and watchdogs.

The lighting of any property or plant depends a great deal on its vulnerability and its accessibility. Locations that are along highways, railroad tracks, near woods or underbrush, on dead-end streets, near deep banks, beside piled-up materials, close to bridges, alongside docks and piers, are particularly vulnerable. Other areas that need particular attention from the lighting standpoint are entrances to buildings and yards, spaces between buildings, yards, alleys, and parking areas. Some general rules to follow in planning any protective lighting installations are:

Provide enough light.

Avoid glare in the eyes of the guards.

Avoid dense shadows.

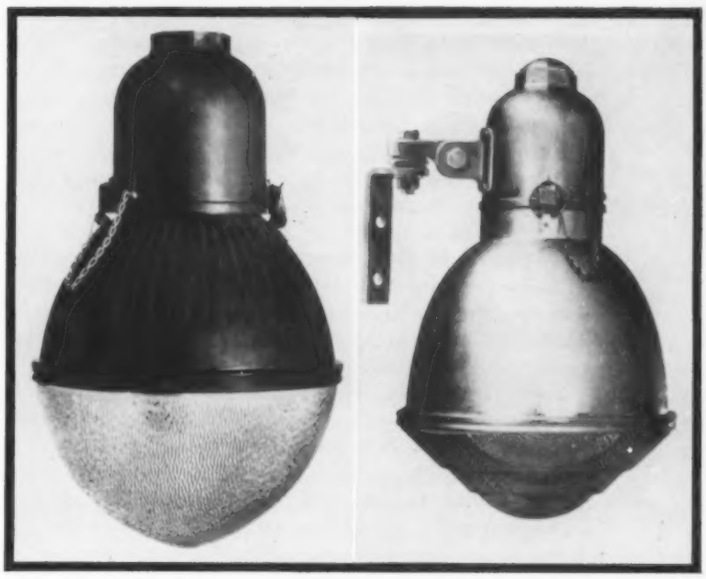


Figure 2 — Typical two-way asymmetrical and symmetrical units for lighting boundary fences and yards.

Protect lighting equipment and wiring to minimize interruption.

Have equipment easy to maintain.

Use light colors of paint to increase visibility.

Avoid pointing flood lights up and down railroad tracks, rivers or roads.

Provide one or more supplementary searchlights, supplied with an independent source of power, which can be directed by the guards.

The lighting of boundary fences and the areas immediately adjacent to them is usually the first consideration of a protective lighting program. The amount of light necessary for lighting this area depends upon its classification. Such locations as ordnance plants, ammunition dumps, etc., would be classed as critical areas and would probably require levels of illumination of the order of one footcandle, whereas other areas of a non-critical nature might require only about 0.10 footcandle. There are four basic types of lighting equipment available for this purpose: street lighting luminaires, flood-lighting luminaires, Fresnel lens units, and the conventional RLM or angle porcelain-enamelled reflectors. (Figure 2.) In the selection of this equipment consideration should be given to the type of guard service employed; that is, whether the guards are located in a stationary tower or whether they are patrolling on foot or in an automobile.

Illumination along the fence lines should be fairly uniform. The point midway between units represents the most vulnerable spot, and therefore the illumination here, both inside and outside the fence line, should be such as to make it impossible for an intruder to conceal himself even though one of the lighting units may be out.

It is generally agreed that good uniform illumination for a distance of at least 50 feet outside the fence line

is necessary for satisfactory protection. It is also well to paint the fence white, or at least to whitewash it, as an intruder is generally more visible against the light background. If the fence is a wire netting, it should likewise be painted white, but since one can see through it, advantage should be taken of this fact to increase the guard's area of view. This can be done by lighting the area outside the fence line.

The effective lighting of property entrances is very important. Anyone approaching should be readily seen and scrutinized. It is advisable to provide light for an appreciable distance around the entrance so that if an intruder should rush by the guards to gain entrance, he would not immediately be lost to the view of the guards. Flood-lighting projectors on roofs of near-by buildings can furnish good supplementary lighting around entrances provided they are mounted sufficiently high so they are not annoying to those who approach the entrance on legitimate errands.

An alternate method is to employ some type of street lighting units installed in the usual manner at the entrances and for a distance of at least 200 feet from the entrances.

Where there are buildings, apparatus, or stores of important material, it is necessary to protect them by means of yard lighting, which may be either in addition to or in place of fence lighting. The buildings or apparatus need not be high-lighted, in fact it is more desirable to adequately illuminate the area around them. This can often be accomplished by locating flood lights on the structure itself and lighting the area around the structure. Careful placement and direction of the floodlights is necessary to insure against glare to the guards and adjacent property and against dangerous shadow areas which would provide hiding places. This latter requirement is usually met by means of multi-directional lighting. The necessary degree of uniformity in coverage is usually accomplished by a suitable degree of beam overlapping. Floodlights are admirably suited to this type of lighting since they are available in a wide range of sizes with a variety of beam spreads which permit the light to be tailored to meet almost any requirements. Lamps of the reflector type are also available. For small areas within 200 feet of buildings, these 150-watt Mazda projector lamps, the type depending on the height of the building, offer an excellent means of floodlighting. (Figure 3.)

Where material is stored in outlying sections of the yard, it might be quite difficult to locate the projectors on buildings and thus light around this stored material without having objectionable shadows. In such cases it may be necessary to place units on a pole which is located at a strategic point. It may be desirable to light a large section of the yard from such a pole since it is often more economical to bring the wiring to one location rather than to distribute it around the roofs of the buildings. Poles should be placed so that any location where entrance may be gained easily or any location which may serve as a place for concealment is well lighted. Because of the variety of locations of buildings in the yard, no specified method of lighting can be given that will cover all cases.

In addition to the general lighting provided at property entrances, and in the yard entrances, it is

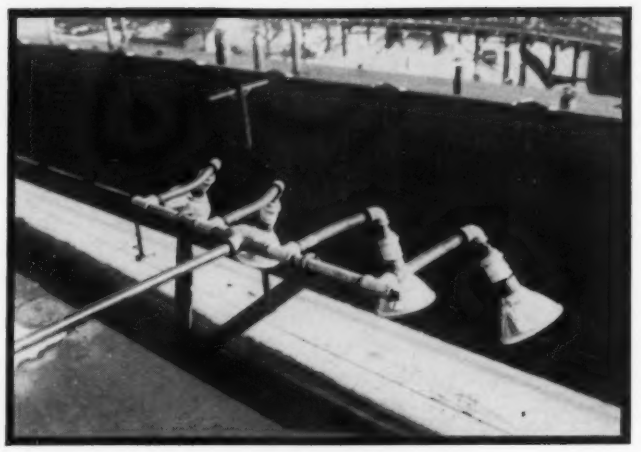


Figure 3 — The PAR projector lamps offer a quick and handy means of providing light at a central point. Here several have been used to cover the desired area.

Many localities have electrical codes requiring the use of conduit. The short lengths of conduit were bent on the job to aim the lamps in the desired direction. Iron straps support the rig used on this building.

very desirable to provide supplementary emergency lighting by means of high-powered search-lights. These can be mounted on the roof of a guard tower or some suitably located building and manually controlled from within. To be most effective as emergency sources, these searchlights should be served by a separate source of electrical power. In addition to their use as emergency sources, they can be valuable as supplementary lighting equipment as they permit the more thorough examination of suspicious movements or indication of trouble within their range either inside or outside the plant area. (Figure 4.)

Industrial plants located in congested districts with residents nearby have had complaints from the neighbors because the light necessary for protection shines in the bedroom windows. Because buildings and yards of these homes provide excellent places of concealment, it is important that the area around the plant be lighted so that approaching prowlers can be seen easily. A good solution to this problem is to use the Mazda projector floor or spotlamps hung vertically from the roof or upper windows on about 20 to 30-foot centers. These provide a bright ring of light around the plant without much annoying stray light. Even the small amount of normal spill light from these lamps may be screened out by using the standard spill ring shields which are available for this purpose.

The generating plants and sub-stations supplying vital industries are very apt to be singled out for attack. At the generating plants the feed water intake, the cooling pond, and the coal handling machinery are the most vulnerable points of all and are relatively easy to damage unless they are carefully lighted and adequately guarded. In the case of feed water intake, the anchoring of a protective boom above it is a good precautionary measure. It may stop explosives being floated down stream.

In the case of sub-stations, floodlighting is required for an appreciable area around the fence in addition to the inside maintenance lighting where this is provided. Here is a case where it is very important to keep the undergrowth trimmed well back. This combination makes it easier to detect and deal with prowlers.

Since most of the vulnerable equipment of a water works is located within buildings, the protective lighting problem is not particularly acute. The floodlighting of such areas as aerating ponds, filtration beds, etc., can be handled in the same manner as industrial yards.

Bridges are particularly vulnerable to attack during wartime. Railroad bridges are easily reached and usually are more susceptible to attack than highway bridges. In order to guard bridges properly it is necessary to light the anchoring piers and the approaches as well as the supporting piers. In outlying sections the approaches to bridges should be closely studied to see if there are any desirable places from which to launch an attack. If near enough to the bridge, these should be lighted. On the small bridges it is usually feasible to use floodlight projectors on shore and direct them to the piers on both the up stream and downstream sides and from both banks. It is also necessary to light the water for an appreciable distance, say about 300 feet from the bridge—particularly on the upstream side—so that any floating objects can be seen. An auxiliary searchlight under the control of a guard is very desirable so that suspicious objects may be easily picked up. In populous neighborhoods it may be necessary to confine lighting closely to the bridge on account of glare.

Dams supplying war industries are, like bridges, particularly vulnerable to attack in times of war. The problem in protecting them from saboteurs is very similar to that involved with bridges except that the down-stream side is less vulnerable. The approaches, anchorages, and water 300 feet above the upstream side should be well lighted and protected. It may not take a very large float to carry enough explosive to start a break in the dam. Water pressure can do the rest—flood out a defense plant or shut down a generating station.

Both the water and land approaches to certain piers and docks need the benefit of the protection of lighting and guards. In the installation of floodlighting equipment extreme care must be exercised in protecting the pilot's eyes from glare. It might prevent him from seeing navigation aids or detecting navigation hazards. This is best accomplished by mounting the floodlights high on buildings or poles. It is also important that the floodlighting equipment does not extend beyond the pier as otherwise it might catch in the ship,s rigging. Auxiliary searchlights are very valuable here since they permit the periodic observation of more distant waters, thus protecting the approach of suspicious craft.

Since protection is the main requirement of lighting, it is obviously important that the security of the wiring be given vepy careful consideration. Wherever possible it should be installed underground, and the pole wiring should be either inside the pole or in rigid conduit so it cannot easily be molested. The control equipment should be well protected, preferably indoors. Automatic devices such as time switches, photoelectric relays, etc., are often used. Auxiliary manual control should also be provided.

For long runs, such as lighting boundries with street-lighting type equipment, series circuits may be preferable. Generally speaking, they are more economical and more easily controlled than the multiple circuits. Multiple circuits of the loop type are preferable for floodlighting and searchlight installation. Multiple service is usually readily available in the immediate area in which they are being used. Multiple circuits are of low voltage than series circuits, and consequently they can be handled by workmen who are not experienced in or equipped for high-voltage work.

It is most important that the spacing and mounting ratios for the particular lighting equipment used be such as to provide adequate illumination along the fence line, in the yard area, or anywhere else in event of lamp outage. Even with proper spacings, maintenance is of utmost importance since safety is at stake. There should be careful consideration of the electrical and mechanical features of the protective lighting installation as it affects maintenance, especially from the standpoint of safety and ease of replacing lamps and cleaning.

It should also be remembered that protective lighting must be capable of filling its requirement during heavy weather and smoky atmospheres when the

Figure 4 — With the adjustable searchlight on this observation tower, the guards can quickly spot prowlers, smouldering fires, etc.

saboteurs perhaps are most likely to appear.

A third phase of steel mill lighting in wartime is blackout lighting. Basically this means that an brightness, such as direct from a light source, reflected brightness from illuminated surface, or brightness from some process, must not be visible to an experienced dark-adapted aerial observer under the most favorable conditions.

A blackout, contrary to the thinking of many, does not conceal the presence of cities. There is sufficient light for aerial activity on cloudless nights with only starlight above, which is of the order of 0.0002 footcandles. However, blackouts can be effective in depriving enemy airmen of possible reference points which might aid them in making attacks.

For building interiors the requirements of blackout may be met by various methods:

At one time it was proposed that factories use only carefully controlled local lights, a sort of "pin hole" lighting, with the glass windows left unobscured. There are numerous fallacies in this idea. While it is possible to reduce the amount of illumination sufficiently to permit reasonable facility of movement without observing the windows, under these circumstances no real production can be accomplished. The accident hazard is great, and morale is impaired by the effort of seeing in the gloomy interior. Furthermore, specular reflection from shiny work surfaces, glass, oil films, etc., would betray the position of the plant. Suffice it to say that this method was tried in England and abandoned for these reasons.

Another method of "blackout" that has merit in sections where actual raids are likely to be infrequent and of short duration is to leave the windows unobscured and keep the full productive lighting going until an actual raiding party is reported on the way, then "blackout" and have the employees seek shelter for the duration of the raid. (Figure 5.) The dim blackout light, just adequate for workers to seek shelters, can be provided by an auxiliary system of approved blackout lamps or fixtures, or in some cases by dimming the regular lighting circuit. (Figure 6.) Care must be taken to pull only the proper lighting circuits, and not the main switches which would stop elevators, ventilating fans, fire pumps, and oil burners, let alone various work in process that cannot be stopped in a matter of a few minutes notice.

An aid in getting about such a black-out plant is the use of fluorescent and phosphorescent materials. The former must be constantly stimulated by a source of near ultra-violet, such as a mercury lamp with a purple corex glass filter which stops the visible light. The latter, the phosphorescent materials, continue to glow many hours after the regular lighting which stimulates them is turned off. These materials have many uses such as in the form of arrows or strips along aisles, or for marking obstructions. Signs, instrument panels, dials, gauges, valves, and even printed instructions can be made visible in the dark with these materials. The material can also be used as clothing or parts of clothing, such as arm bands, for the protection of the wearer.

The most complete and effective method of providing a blackout is by obscuration. This consists of making all windows, doors and other openings com-

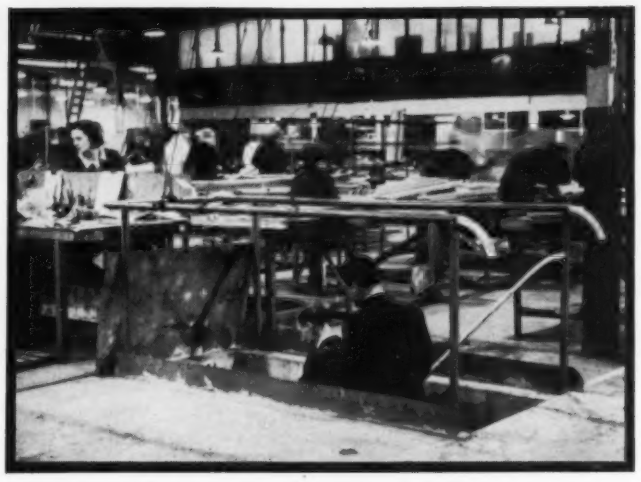


Figure 5 — Entrance to indoor shelter which is easily accessible to employees during emergencies.

pletely light-tight and then providing full productive lighting inside. This procedure is particularly recommended for plants in which war production activities are carried on. (Figure 7.)

Lightlocks should be provided for entrances and exit openings of such blacked-out buildings and also for the openings normally used for providing ventilation. A light lock consists essentially of a tunnel or passage having dark walls and ceiling, so constructed that no direct light source or light reflected from the source is visible from the exterior at any time. Any light source near the interior entrance of the lock should be shielded to screen direct light from entering the lock.

The obscuration of windows may be accomplished by means of paint, adhesive coverings, screens, shutters, light loops, or other approved means.

The paint should be weatherproof, matte and drab in color. It should be applied carefully to make sure that no corners and other missed spots permit passage of light. On vertical glass surfaces paint may be applied to either or both sides. On other than vertical glass surfaces paint should be applied to the exterior surface to reduce the specular reflection of the glass. Obscuration by paint alone has two disadvantages: one, that the glass may be shattered by a blast concussion and the lighted interior exposed, and second, artificial illumination will usually be required in the daytime. The interior surfaces of windows and skylights should be painted light in color. This provides for better utilization of light and is helpful in keeping up the morale of the worker.

Adhesive coverings should be opaque and adhere strongly to the glass and should possess considerable tensile strength. Cloth, paper, or fibrous materials can be used. Weatherproof materials should be on the exterior of the glass to minimize specular reflection. An advantage of this method over paint is that the scattering of glass may not be so pronounced.

Rigid screens and shutters should fit closely in the openings or overlap the openings sufficiently to avoid

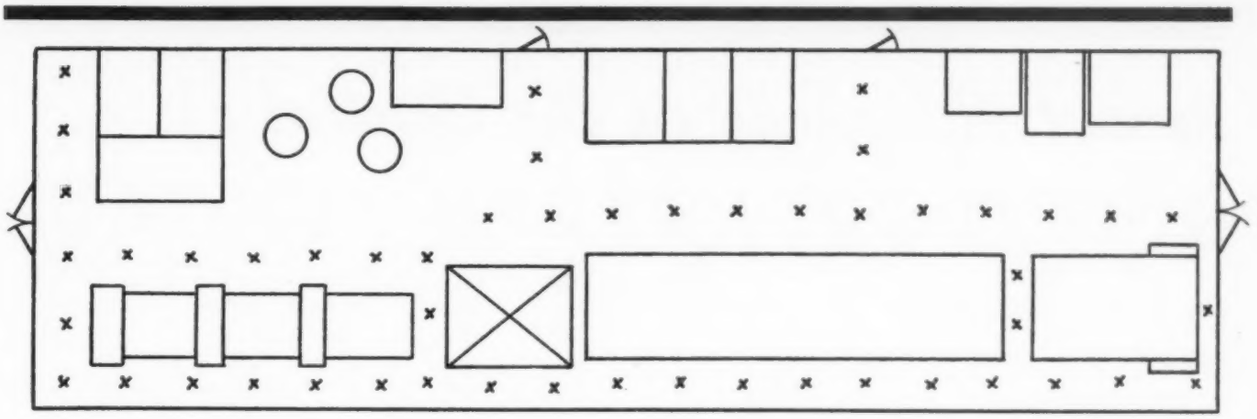


Figure 6 — A suggested means of providing just enough light to safely and rapidly empty the building of employees. Here approved Blackout Lamps (x) are positioned along aisles and passageways on about 15-foot centers.

light leakage. It may be desirable to hold such screens in place by flexible or electric means to absorb some of the shock of blast concussion. Various types of opaque covering or material such as curtains, blankets, builder paper, plywood, fibre wood, or cardboard may be used. Some of the materials may be mounted on light wooden frames. In selecting material for covering openings for obscuration purposes, particularly in vulnerable locations, thought should be given to the providing of protection against splinters and flying glass.

The iron and steel industry in its various phases is easily identifiable by the glow caused by various processes. Sometimes these mills and their slag dumps are visible from the air for 25 miles under favorable conditions.

There seems to be no general method of glow or glare prevention suitable for universal application.

Figure 7 — "Blackouts" are no problem in this windowless plant. All shifts work under the same conditions.

In any plant where glow occurs in the process due consideration should be given to planning the sequence of operation so that the phase or phases during which glow does occur takes place during daylight hours if possible. Artificial fog and smoke screens have been used successfully for concealment of glow, especially during the daytime.

Light from the top of blast furnaces, cupolas, open hearths, and annealing furnaces, has been screened by the use of large fireproof louvred hoods carried over the furnaces. For some operations such as glow from inspection holes, slag pipes and other apertures, sheds can be used to screen the light.

Storage of highly inflammable materials such as petroleum products in tanks should receive special consideration on account of the grave risk of fire since fire will nullify blackout measures.

It should be remembered that not all air attacks are confined to night operation. In planning blackout procedure for any industrial plant consideration should be given to daytime protection by camouflage. In some cases this daytime camouflage may provide night blackout protection at little or no additional cost.

There has been some controversy over the use of blue vs red light during blackout. This is best answered by quoting from a recent communication issued by the War Department: "Recent War Department tests of illumination under blackout conditions conclusively demonstrated that blue illumination is more easily seen from air by experienced observers and less helpful to ground activity than any other color. No further use will be made of blue illumination for blackout purposes. Of all colors in visible spectrum deep red illumination is least visible from air, most helpful on ground, and best suited to preserving dark adaptation of eyes. Where color must be used in order to lower intensity of lights deep red will be used. Consideration must be given the fact that red illumination is not normal and if improperly used may betray the installation it proposes to conceal. Low intensity white light is suitable for purpose of blackout illumination in majority of instances . . ."

Recent Advances in the Control of MULTI-FUEL FIRED FURNACE

By J. C. Vaaler

Askania Regulator Company
CHICAGO, ILLINOIS

PRESENTED BEFORE
A. I. S. E. ANNUAL CONVENTION
CLEVELAND, OHIO

. . . . automatic combustion control can be applied to installations using more than one fuel . . . .

▲ THE use of more than one fuel on open hearth, soaking pit furnaces and boilers has stimulated the development of automatic control equipment for these applications. The earlier applications of control to furnaces fired in this manner were usually accomplished by equipping the air fans with more than one inlet. With this arrangement it is possible to control combustion air in relation to each fuel being burned by regulating a damper at the inlet of the fan.

A later development in control equipment provided a means of summarizing the various fuel flows so that an index of total air requirement would be secured. From this index combustion air could easily be controlled.

The use of multi-fuels not only aids in better fuel distribution throughout the plant, but also permits greater flexibility in operation to control flame character.

The desired features of any summarizing device are as follows:

1. Compensate for air infiltration.
2. Use any flow impulse characteristic.
3. Adjust for various atmospheres.

As most flow indications follow a square root law, that is, the differential pressure varies as the square of the flow, the corresponding relationship between the two is parabolic. This makes it impossible to add differential pressures representing individual fuel flows, to obtain an indication of the total air requirement. Therefore, any method which is employed to proportion combustion air to more than one fuel flow, requires that this relationship be taken into consideration.

One method which has been used to summarize fuel flows is to extract the square root cut of the flow indication. Then by totalizing these values an indication of total fuel measurement is secured.

Another method, which has been in use for a number of years, is to make use of pilot flows proportional to the respective fuel flows and to summarize these pilot flows, thus securing an index of total air requirement.

With the pilot flow arrangement let us assume that two fuels are being burned, both under manual control, the first being coke oven gas and the second fuel oil. For each fuel a regulator would be provided so as to develop a pilot air flow proportional to each fuel flow.

The summarizing device for this purpose consists of an assembly of piping, so arranged as to permit entry of a low pressure air supply at constant pressure This low pressure air supply is divided into two branches, in each of which is located a control valve and an orifice plate. Both lines are later brought together so that the flows developed in both lines are totalized by a common orifice.

The control valve in each line is operated by a control cylinder, that in turn is controlled from a ratio regulator to develop a pilot air flow proportional to each fuel. Thus it can be seen that when two pilot flows are brought together and summarized by a common orifice, the differential developed by this orifice becomes the index of total air required. This differential pressure is then used to actuate the combustion regulator so that combustion air is supplied in proportion to the total amount of fuel being burned.

Many variations of this summarizing principle have been employed in open hearth and soaking pit practice to secure the desired operation peculiar to any plant condition.

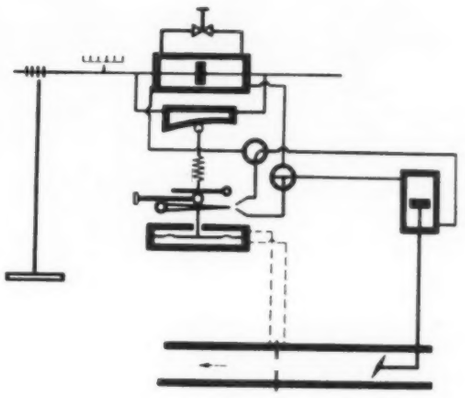
In many cases the problem of securing a true measure of fuel flow is further complicated if the impulse or indication of fuel flow, follows other than the square root law. For example the recirculating type oil burner has a more or less straight line relationship between pressure and flow.

Another factor which enters into the problem is air infiltration. In this instance, with air infiltration of varying magnitude, the relation between the desired air differential and the fuel impulse becomes rather involved.

Still another point are the errors in measurement due to improper orifice location with respect to proper lengths of straight pipe.

The equipment described in the following supple-

ments the summarizing equipment described previously and provides for the features stated in the basic problem.



FLOW-STROKE TRANSFORMER

Figure 1

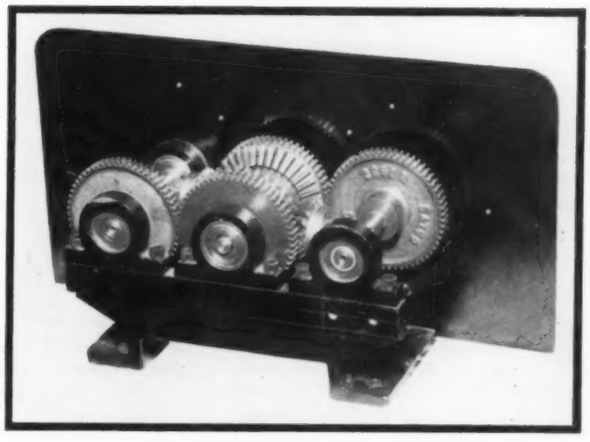
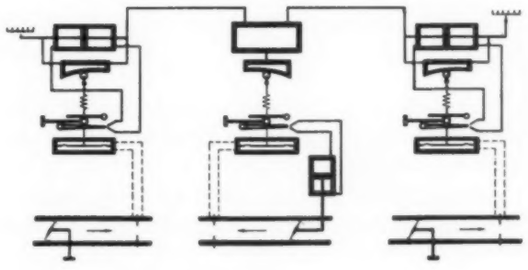


Figure 2



TOTAL AIR FLOW CONTROL WITH MANUAL ADJUSTMENT OF TWO FUELS

Figure 3

Basic Solution

The first portion of equipment required to accomplish the above is done by means of a "transformer", which converts or transforms the flow impulses into proportional cylinder movement. The illustration shows a standard flow regulator which is used for this purpose. The differential pressure developed by an orifice in the fuel line acts upon a diaphragm system, so that the jet pipe controls through it hydraulically operated cylinder an adjustable cam in such a way as to balance the force of the diaphragm by compressing the opposing spring. Thus there is a definite relation between fuel flow and the cam movement. The adjustment then made is such that the movement represents "air demand" for a given fuel flow.

Having thus obtained a movement, which is directly proportional to the air requirement for the fuel which is being used the next step is to summarize this indication with one obtained from other fuel or fuels. It should be noted that the cam used on this regulator has an adjustable pitch which permits compensation for any characteristics of the fuel impulse.

After establishing a mechanical movement, which is directly proportional to the air requirement for one fuel, it is merely necessary to take the same step for the second fuel and add the mechanical movements of both. Thus we establish the air requirement for the two fuels.

The summarization of the two mechanical movements is accomplished by means of a summarizing gear (Figure 2). This device has the ability to add or subtract mechanically two mechanical movements so that the result is always the correct sum of the two. In principle it is similar to that which is employed in the differential gear of an automobile, in which the drive shaft will remain at the constant speed, while one rear wheel is turning faster than the other while making a turn.

The summarizing gear is merely the reverse operation of the differential on a car in which the two shafts are moved in relation to the air requirement and the summation of these two movements is summarized by the summarizing gear.

Assume a typical example where two fuels are being burned and the orifice plate located in the line of fuel No. 1 develops a differential pressure proportional to the fuel flow. This differential in turn actuates through the regulator its adjustable cam and cylinder a mechanical movement proportional to the fuel flow so as to set up the actual air requirement. This mechanical movement is directly connected to one-half of the summarizing gear.

For the second fuel a similar arrangement is provided and its mechanical movement, proportional to the fuel flow and setting up its air requirement, is connected to the second half of the summarizing gear.

Total Air Flow Control with Manual Adjustment of Two Fuels

Figure 3 is a layout which provides for total air flow control with manual adjustment of two fuels. The diaphragm of the regulator at the left measures the quantity of fuel No. 1 and the differential devel-

oped by the orifice in this line is imposed on the diaphragm of the regulator. This actuates the control cylinder in such a way that it develops the movement, which represents the air required to burn the quantity of fuel No. 1 being used. This mechanical movement is in turn transmitted to the summarizing gear shown in the center of the illustration.

Similarly, the second regulator at the right establishes a mechanical movement which sets up the air requirement for fuel No. 2.

The mechanically summarized motion of both regulators is thereby transmitted to the cam of the combustion regulator at the center of the illustration. As an increase in air requirement occurs, the spring as shown is compressed, increasing the loading against the jet so as to cause the operating cylinder, which this regulator serves, to open the butterfly valve in the combustion air line to proportionately increase the air required for combustion. The secondary impulse for this regulator is, of course, the differential pressure developed by an orifice in the air line.

Adjustment for fuel air ratio are made in the usual way by adjusting the ratio slider.

Total Air Flow Control with Automatic Flow Control of Base Fuel No. 1, and Manual Control of Fuel No. 2

In Figure 4 the regulator at the left controls the quantity of fuel No. 1. The actual flow is determined by the setting of the hand wheel adjustment which provides a means of setting the mechanical motion of the cam in such a way that the regulator controls through its hydraulically operated cylinder the valve in the fuel lines. The measure of fuel flow is developed by the orifice and in turn imposed on the diaphragm of the regulator. This is a simple type flow regulator with the added feature of the cam and a means of transmitting the mechanical motion to the summarizing gear.

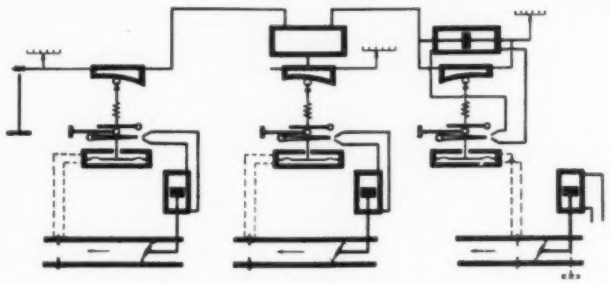
The control of fuel No. 2 is manually adjusted and a measure of the fuel is imposed on the diaphragm of the regulator at the right. This regulator develops a mechanical movement establishing the air required to burn fuel No. 2 and is directed to the summarizing gear.

The control scheme from this point on is the same as that described in the previous arrangement so that combustion air is supplied in proportion to two fuels.

At this point it should be considered that the combustion regulator may be adjusted for air infiltration by the cam setting. The spring tension on this regulator is so adjusted by this cam that the actual air flow will remain zero until the total air required to burn fuels No. 1 and No. 2 is equal to the amount of air infiltration.

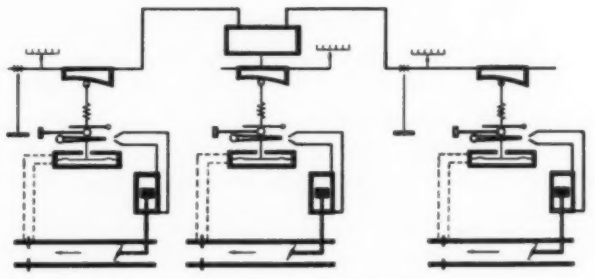
Total Air Flow Control with Individual Automatic Control of Both Fuels

The control arrangement in Figure 5 is an amplification of that shown in the previous arrangement in which fule No. 1 is automatically controlled by the regulator at the left. The flow adjustment is accomplished by the manually adjusted hand wheel. The regulator will control the fuel in relation to this hand



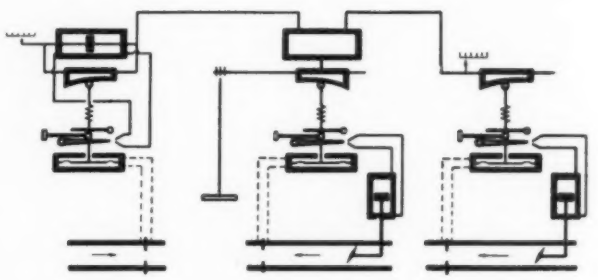
TOTAL AIR FLOW CONTROL WITH AUTOMATIC FLOW CONTROL OF BASE FUEL NUMBER ONE, AND MANUAL CONTROL OF FUEL NUMBER TWO

Figure 4



TOTAL AIR FLOW CONTROL WITH INDIVIDUAL FLOW CONTROL OF BOTH FUELS

Figure 5



TOTAL HEAT INPUT CONTROL PROVIDING FOR A VARYING SUPPLY OF PRIMARY FUEL AND AUTOMATIC MAKEUP OF SECONDARY FUEL

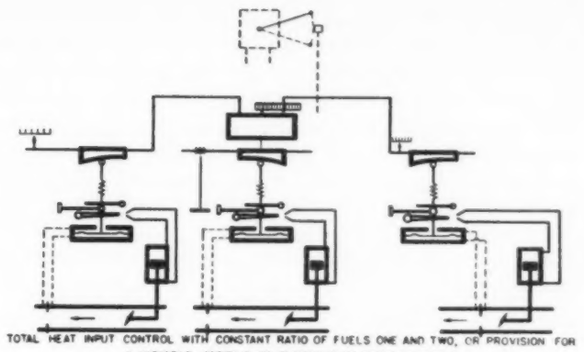
Figure 6

setting. The flow setting is transmitted mechanically to the summarizing gear so that the fuel requirement is established for fuel No. 1.

In a similar way fuel No. 2 is under automatic flow control and the air demand is transmitted to the summarizing gear.

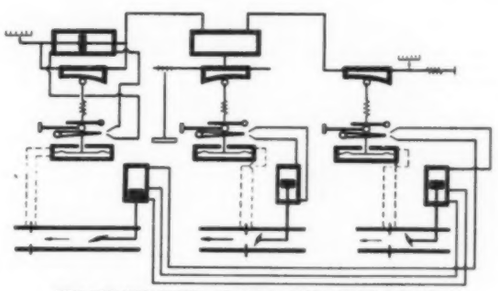
Here it should be noted that the flow settings are both mechanically transmitted to the summarizing gear so as to establish the total air required for both fuels.

The combustion regulator in the usual way controls the air required for burning both fuels.



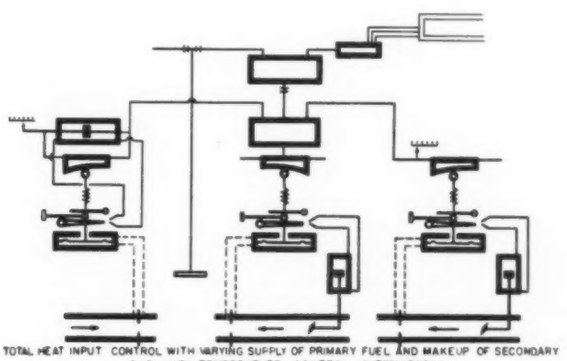
TOTAL HEAT INPUT CONTROL WITH CONSTANT RATIO OF FUELS ONE AND TWO, OR PROVISION FOR A VARIABLE SETTING OF THE RATIO OF THE TWO FUELS

Figure 7



TOTAL HEAT INPUT CONTROL WITH VARYING SUPPLY OF ONE FUEL AND AUTOMATIC MAKEUP OF SECOND FUEL WITH PROVISION TO CUT DOWN SUPPLY OF PRIMARY FUEL IF TOO MUCH IS AVAILABLE

Figure 8



TOTAL HEAT INPUT CONTROL WITH VARYING SUPPLY OF PRIMARY FUEL AND MAKEUP OF SECONDARY FUEL WITH TEMPERATURE CONTROL SUPERIMPOSED

Figure 9

Total Heat Input Control Providing for a Varying Supply of Primary Fuel and Make Up Automatically of a Secondary Fuel

If a constant heat input is required it is permissable to arrange the control system so that total air flow controls first, since a definite amount of Btu input usually requires the same amount of air.

The regulator at the middle of the diagram (Figure 6) is therefore adjusted for a constant heat input by means of the hand setting wheel and the total air is admitted to the furnace in relation to this flow setting. This establishes the total air demand on the summarizing gear. A portion of the total heat input demand is taken care of by the regulator at the left, which controls the movement of its cylinder in relation to the amount of primary fuel available. Thus a portion of the total heat required is taken care of by the primary fuel.

The remainder of the total heat required is established by the movement of the shaft on the summarizing gear which in turn actuates the cam of the regulator at the right of the diaphragm. This cam in turn actuates the regulator loading so that it controls its cylinder to admit the proper amount of fuel to make up the total heat required. An orifice in the secondary fuel line establishes a differential to counterbalance the primary loading on the secondary fuel regulator.

Total Heat Input with Constant Ratio of Fuels No. 1 and No. 2, or Provision for a Variable Setting of the Ratio of the Two Fuels

With the arrangement shown in Figure 7 total heat input is also established primarily by the total air flow. Here the summarizing gear simultaneously adjusts the setting for the regulator controlling fuel No. 1 and fuel No. 2. Thus for a given total air flow the summarizing gear establishes the fuel flow setting for either fuel. The regulator in turn at the left controls the primary fuel in relation to its load setting previously established by the summarizing gear and the regulator at the right controls fuel No. 2 in relation to the setting of the summarizing gear.

If it is desired to change the ratio between the two fuels, this is accomplished by changing the ratio of the output from the two shafts on the summarizing gear.

Total Heat Input Control with a Varying Supply of Primary Fuel and Make Up of Secondary Fuel with a Temperature Control Superimposed

Basically the arrangement in Figure 8 is similar to the one previously described without the temperature control. However, in this case the temperature control has been superimposed so as to over-rule the total heat input whenever the temperature would rise beyond a desired amount.

An extra summarizing gear is added to the control arrangement so that the temperature control unit through its motor operator will change the total air flow setting.

If this method is used on an open hearth furnace where the roof temperature control is superimposed, the only time the temperature control will come into action will be when the roof temperature exceeds the maximum value for which it is set. After the roof temperature returns to its normal value the control equipment will continue to supply the total amount of fuel established by the setting of the total heat input.

Total Heat Input Control with Varying Supply of Fuel and Automatic Make Up of Second Fuel with Provision to Cut Down Supply of Primary Fuel if too much is Available

Figure 9 is another variation of the total heat input control in which the regulator at the left measures the total amount of primary fuel available and the remainder of the fuel is supplied by the regulator at the right. Assuming that too much of the primary fuel is available, the regulator at the right would, of course, close the valve cutting off the supply of the secondary fuel. When the cylinder reaches its end position the inter-connecting oil lines with the cylinder operating the valve in the primary fuel line would become effective so as to cut down the supply of primary fuel. In this way should it ever occur that too much primary fuel could be available it would be cut down automatically by this arrangement.

In addition to the above basic schemes there are, of course, the problems of burning more than two fuels. Adaptions of these arrangements have been worked out for specific applications.

DISCUSSION

PRESENTED BY

J. R. GREEN, Manager Steel and Ceramic Division, Brown Instrument Company, Pittsburgh, Pennsylvania

M. J. BOHO, Sales Engineer, Hagan Corporation, Pittsburgh, Pennsylvania

M. J. BRADLEY, Market Extension Engineer, Leeds and Northrup Company, Philadelphia, Pennsylvania

J. R. GREEN: The addition of impulses proportional to flow by means of the differential gear appears to be an ingenious mechanical system. In addition to the methods outlined for summarizing total Btu flow with multiple fuels, mention can be made of the addition of pressures or of electrical currents which are directly proportional to the flow of each individual fuel.

When a temperature limiting device is superimposed upon a flow control system, experience has shown the advantage of doing so by means of a throttling action rather than a step or knock down change. Not only do the controls function without danger of setting up a hunting action, but also operators will take advantage of the protection offered by the temperature limiting device to increase heating rates, rather than limit the manual settings of maximum fuel flows in order to keep a limiting device from radically unsetting the furnace.

In the case of open hearth firing, the functioning of a temperature limiting device during the lime boil should preferably reduce fuel alone or change the fuel air ratio to compensate for the additional fuel developed from the bath. Possibly the mechanical device described in the paper could be so connected.

The use of an artificial loading on air flow regulators to compensate for infiltration of air, is the same in principle regardless of the method of summarizing the fuel flow. Unfortunately, the amount of air infiltration or loss after metering is frequently a variable, depending upon temperature, draft and reversal damper seating, as well as the physical condition of the furnace. Until such time as suitable continuous analysis and control equipment is available to measure the efficiency of combustion in terms of excess oxygen or unburned combustible at the exit of the furnace proper, and control air volumes from that measurement, the refinements and mechanical devices of air fuel ratio equipment such as described in this paper will serve excellently to reduce fuel costs, by the proper ratioing of combustion air regardless of the multiplicity of fuels.

M. J. BOHO: I have nothing further to add in connection with regulators design but do wish to touch upon some of the practical problems that may spell success or failure to a multi-fuel fired furnace control installation.

When it is desired to operate a furnace in such a manner that a primary fuel is used up to the limit of its availability and any deficiency made up by the addition of a secondary fuel, a special burner problem is raised.

On an ordinary single-fuel fired furnace, for example, the burners are designed to operate over a range of five to one or in some cases as high as ten to one. While the primary fuel may, in fact, be used over the range for which it was designed, the secondary fuel may be burned over a much wider range; for example, there may be enough primary fuel available to supply 98 per cent. of the total heat requirement, at which time only two per cent must be made up by the addition of the secondary fuel. At other times, no primary fuel may be available and the secondary fuel may have to be used to supply the total fuel requirement. Under these conditions, the burners firing the secondary fuel may be required to operate over a range as great as fifty to one, and, in other cases may go as high as ninety to one. This, as we all realize, is an extremely wide range over which to operate any burner and it is most important that burner design be carefully considered in order to insure that the benefits of multi-fuel be fully realized.

A second factor is the placement of burners to insure prompt ignition of the secondary fuel and complete mixing with its quota of total air supplied.

Still another factor which must be kept in mind is the question of air measurement. Too much cannot be said on the desirability of having an accurate orifice location. While it is quite true that six or seven feet of straight pipe ahead of an orifice in a six or eight inch gas line may provide the required number of pipe diameters for accurate results, when considering the location of orifices in air lines it requires anywhere from fifteen to twenty-five feet of straight run in which to install an orifice, for equivalent metering results. If this is kept in mind at the very beginning of a project, usually some provision can be made by rearrangement of certain machinery to provide an accurate air flow measuring location. Too often, however, the measurement and control problem is not discussed until the rest of the machinery surrounding a furnace installation

has been located and, when it is finally realized that no suitable location for an air flow measuring orifice is available, it may be found that the work has progressed to such a point that it would be much too expensive to relocate the interfering machinery and, as a result, the job may go ahead with at best a half-hearted means for measurement of air flow. Here it must be pointed out that modern regulating apparatus has been perfected to the point where it is extremely accurate, and it is quite possible that the accuracy of the regulating equipment can defeat the purpose of the control if an inaccurate air flow measuring location is used, since, by virtue of the regulator,s accuracy, it will maintain a condition that might be highly undesirable and expensive, just as faithfully as the opposite. The surest way to get results is to install the proper apparatus, together with an orifice measuring location, which will have an inherent accuracy of measurement equal to or higher than the regulating apparatus itself.

When the proper attention is paid to the details of burner design, orifice location, etc., a control system on a multi-fuel fired furnace may sometimes bring in very surprising dividends. We have in mind an installation made recently in a plant in the Pittsburgh district. This steel plant used by-product coke oven gas on most of the furnaces throughout the mill whenever it was available. When an excess of coke gas was present, it was burned under boilers and when there was a deficiency, certain billet heating furnaces were arranged to be operated with by-product tar as the fuel. At the open hearth, tar and oil were used.

The practice had been for the fuel department to notify the operators at the billet heating furnaces to go on tar whenever the supply of coke oven gas got dangerously low, as indicated by a falling off in coke over supply pressure below a predetermined minimum value. The idea was that the operators would use tar rather than gas and, thereby, help keep up the coke oven gas pressure, and, when the gas supply again exceeded the total demand and the pressure began to rise, they were to go back to coke oven gas firing. Because of the frequent fluctuations in gas pressure and because the change-over was tedious, the operators would not immediately return to coke oven gas firing on these furnaces until the pressure was well up and, as a result, they burned much more tar on these furnace than they actually had to in order to balance out the coke oven gas system. A control was installed and arranged so that the furnaces would use up coke oven gas to the limit of its availability and make up any difference between total demand and the coke oven gas supply by the burning of tar. The equipment functioned automatically and required no adjustments by the operator to go from one fuel to the other. As a result, the furnaces used every cubic foot of gas which was available and, consequently, burned approximately 250,000 gallons of tar per month less than formerly. The tar thus saved was used at the open hearth, with a consequent reduction in the amount of fuel oil purchased. Over at the boiler house, more coal was burned to compensate for the increased coke oven gas which was being diverted to the furnaces. The net saving to the plant in lowered fuel oil costs, when the cost of the extra coal was deducted, amounted to approximately $60,000.00 per year, a saving which paid handsome dividends on the original control investment.

The installation of automatic control on multi-fuel fired furnaces requires more careful consideration and attention to details of burner design and burner and air orifice location than an ordinary single fuel-fired job; however, the savings possible in many instances are large and well worth the extra effort.

M. J. BRADLEY: Mr. Vaaler has outlined in a very concise manner methods for totalizing the combustion air requirements for two or more fuels fired at the same time on metallurgical furnaces. He has explained several ways of coordinating the control action so as to be fully automatic, partially automatic and partially manual, and also dominated by temperature requirements. Usually, control functions are designed to operate under a set of conditions which will take care of the industrial requirements at the time the equipment is installed. However, due to changes in the fuel supply and unforseen special requirements on the furnace to take care of industrial demands, the control functions should be capable of being rearranged easily to take care of the new operating requirements.

A low-pressure, air pilot system which provides a flow proportional to the individual fuel flows provides for ample flexibility to meet changing requirements. The low-pressure or fan air supply, which is measured in inches, rather than in pounds pressure, should be provided as an integral part of the control equipment. A constant supply of low pressure air eliminates the troubles inherent with high pressure compressed-air from the plant supply, especially varying supply and condensed moisture and oil vapors which cause errors and increase maintenance.

Orifice measurements when used to actuate control functions should be limited to the optimum working range. Difficulties are often encountered when too great a spread between maximum and minimum flows are allowed to take place. A range up to four to one gives very satisfactory results. If the supply of one of the fuels falls off much beyond this range, provision should be made to automatically turn it off completely and the deficiency be made up automatically by increasing the other fuel

The demand for combustion control equipment is greater on furnaces fired with two or more fuels, and especially when one or all fuel volumes, without warning, may vary from zero up to 100 per cent. Under such conditions it is practically impossible for an operator to manually maintain a desired air-fuel ratio or uniform heating conditions. Automatic combustion control equipment, actuated from metered volume relationships of fuel and air, can follow rapidly and accurately the changing fuel conditions. However in doing so, it also changes to a more or less extent, the appearance of conditions within the furnace due to the changing fuel volume relationships. The changes in the furnace atmosphere appearance is always a source of worry to the operator, who favors holding the air constant under very wide fuel fluctuations or even fuel reductions.

Combustion control equipment, on batch-type, reheating furnaces, may be arranged to function in different ways especially when dominated by tempera-

ture control. The temperature controller reduces gradually, the fuel as the control point is approached. The combustion control equipment may maintain the set air-fuel ratio or increase gradually the proportion of combustion air as the fuel is reduced. On other installations the higher Btu fuel may be reduced to zero before starting to reduce the lower Btu fuel, while the air-fuel ratio may be held at the set value or the air gradually increased. Another method which has been proposed is to hold the air-fuel ratio constant and recirculate hot waste gases into the furnace in direct proportion to the reduction in fuel. These various methods are intended to maintain the same velocity of hot gases and uniform heat distribution within the furnace.

J. C. VAALER: Before explaining the operation of the summarizing gear, I would like to comment on the discussions of Mr. Green, Mr. Boho, and Mr. Bradley.

One of the points brought up by Mr. Green is the limiting device on the system equipped with temperature control that is superimposed over the total heat input control. In this arrangement when the temperature control comes into action total fuel and air are both cut down at the same time. To provide for reduction of fuel rate only during the lime boil the temperature limiting device can be applied to the system so that the combustion air setting would remain at the previous setting.

The suggestions of Mr. Boho on the importance of accurate metering can not be over emphasized. Proper location of orifice and other metering devices may mean the difference between a successful or unsatisfactory installation.

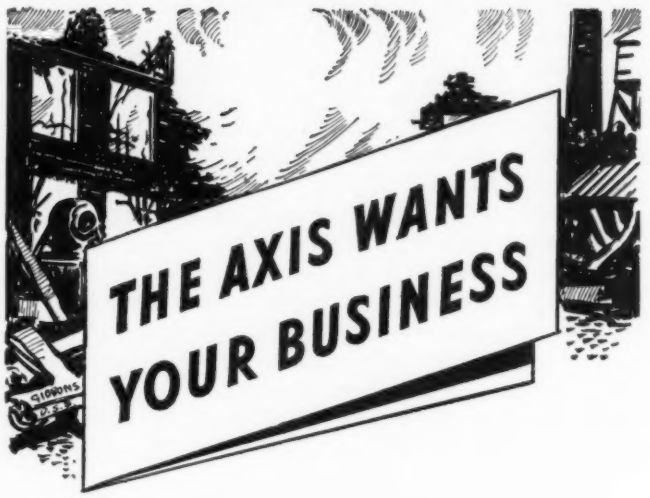
Range of burner operation for multi-fuel fired installations is a most important consideration. In one typical boiler combustion control installation the primary fuel used is blast furnace gas and the secondary pulverized fuel. When a deficiency of blast furnace gas occurs the control is arranged to delay the introduction of the secondary fuel until the demand becomes equal to twenty per cent of the total secondary fuel capacity. Thus the pulverizer is not started until the proper range of burner operation is reached.

Now for a description of the "magic gear box" which Mr. Fisher has so aptly named.

The illustration shows a model which demonstrates its operation. In the control gear assembly is shown two bevel gears both of which are in contact with two smaller gears. The two smaller gears are mounted on a shaft which in turn is keyed to a floating shaft which extends to the outside of the housing. This shaft is used to transmit mechanically the sum of the movement of the two large bevel gears.

The rotation of one of the bevel gears will cause a movement of the floating shaft proportional to the initial movement. By the same action the motion of the second large gear is transmitted to the floating shaft.

The proper connection of these bevel gears in the summarizing gear assembly permits it to add properly the two mechanical movements representative of two fuel flows.



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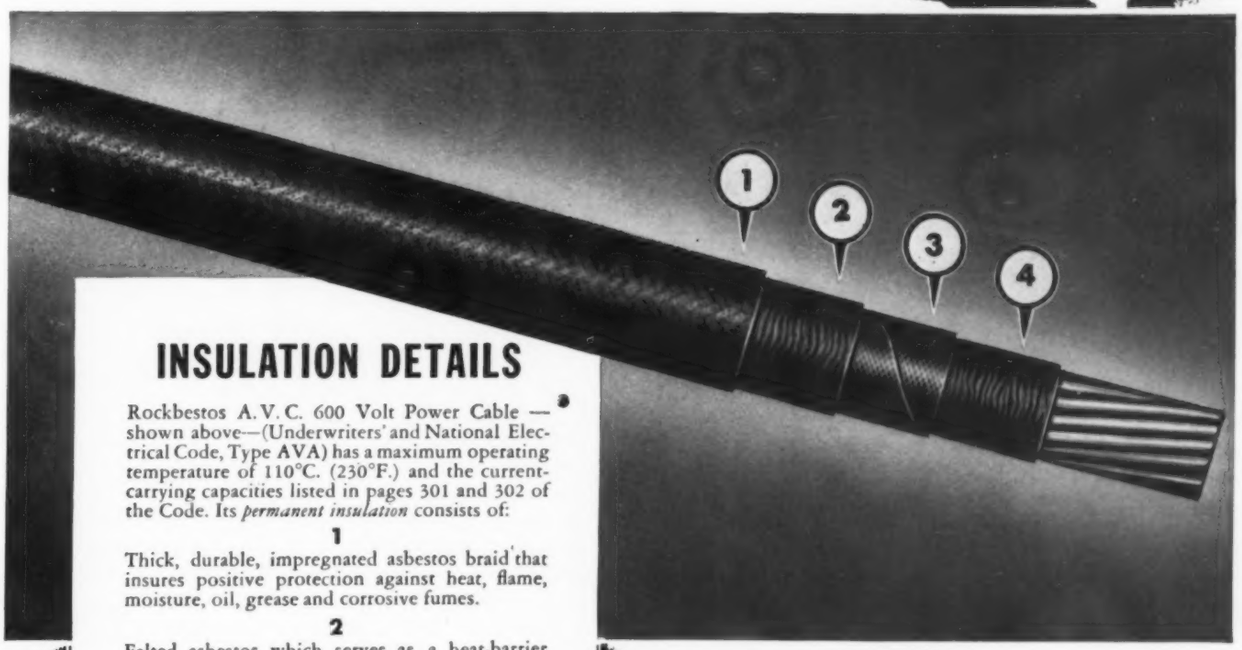

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Abstracts of Papers . . .

To be read at A. I. S. E. Annual Meeting and Conference Pittsburgh, Pa., September 22, 23 and 24, 1942

MILLS AND THE ROLL DESIGNER

By Clifford Elms
Chief Engineer
Pittsburgh Rolls Division
Blaw-Knox Company
Pittsburgh, Pa.

This paper will deal with various problems of the roll designer, and the part he must play in the successful operation of the modern mill. It will give some history of today's mills, and what the designer must know about them in order to get production. It will cover various types of mills, trying to explain the various classifications such as guide mills, continuous mills, looping mills, etc. The part the roll foundries play in the modern mill, and the various kinds of rolls and their uses will be discussed. Many problems and other interesting, not generally known items will be brought out in this paper.

THE USE OF ADDITIVES IN PETROLEUM PRODUCTS

By F. F. Musgrave
Asst. Director of Research
The Lubri-Zol Corporation
Cleveland, O.

In a general rather than technical paper the use of additives in petroleum products is reviewed beginning with early developments of importance such as tetraethyl lead, hypoid gear lubricants, the use of V. I. improvers and pour point depressants.

A general survey of present practice in the field as a whole shows diversification of additive applications in a variety of petroleum products for various purposes. The significance and importance of addition agents is brought out by showing how developments in various types of equipment are frequently paralleled by the introduction of new and better addition agents for the lubricants involved thus providing improved performance in service.

The methods of test now in use for heavy duty crankcase oils are reviewed in some detail and some indication is given of the steps involved in developing a satisfactory chemical treatment from the initial laboratory preparation of possibly suitable compounds through the final field testing and approval tests. The specific value of the combination of a given additive with one particular base oil is stressed and limitations imposed on the interchangeability of additives and base stocks are brought out.

There is a brief discussion of the chemical nature of some addition agents now in use and the semi-empirical nature of fundamental development work in this field is emphasized.

The outlook for the future of addition agents as a whole is suggested as being one of continual progress towards more exact knowledge of the fundamental mechanisms involved with improvements in performance of oil-additive combinations expected to result as our understanding increases and as experience accumulates.

Some slides exhibited at the close of the paper illustrate various phases of work on additives such as specific test methods and comparative data found on such tests.

DEVELOPMENTS IN STEEL PLANT REFRACTORIES

By C. A. Brashares
Technical Department
Harbison-Walker Refractories Co.
Pittsburgh, Pa.

Current demands for tremendous tonnages of steel frequently impose increasingly more severe conditions upon refractory construction in steel plant furnaces. For open hearth roof construction, the development of super-duty silica brick promises improved service under given operating conditions as compared with conventional silica brick. Test data on the super-duty silica brick suggest the possibility of adapting to somewhat higher furnace operating temperatures. The advantages and necessary limitations of super-duty fireclay brick to soaking pit and heating furnace requirements are discussed. The utility of the various high alumina brands and developments particularly in the field of types containing substantial percentages of alumina in the form of corundum, their high refractoriness, load bearing properties and resistance to thermal shock are mentioned. Some studies on the influences of changes in furnace conditions on refractory life are outlined. The advantages of standard sizes and shapes in regard to their possessing a high degree of the desirable properties of a refractory are given. Some trends in refractories for electric furnaces operating at high production ratings are indicated.

RELATION OF FLAME CHARACTER TO OPEN HEARTH OPERATION

By A. J. Fisher
Fuel Engineer
Bethlehem Steel Co.
Sparrows Point, Md.

This paper is a continuation of the subject introduced by the author in his paper before the Association at the 1940 meeting in Chicago.

It deals specifically with a procedure of establishing the most efficient flame for maximum production in the open hearth furnace. The flame is analyzed from a physical standpoint and then from a thermal radiating standpoint. The method of taking and recording the radiating power of flames should be of interest to all open hearth operators and fuel engineers.

THE BLAST FURNACE SKIP HOIST

By Gordon Fox
Vice-President
Freyn Engineering Co.
Chicago, Ill.

Occasionally it is well to revert to fundamentals, to reexamine practices and to question the inviolability of precedent. The topic in hand is approached in that vein.

The low speed steam engine with single gear reduction, used in the early blast furnace skip hoists, was superseded by the single motor driving through a double reduction. The two-motor drive has been substituted for the single motor with considerable success. A recent new design of hoist accepts the superiority of the two-motor drive as a premise and seeks to incorporate this type of drive most effectively as an integral element of the hoist design.

The power required to fill a blast furnace is surprisingly small. Large motors are dictated solely by torque considerations.

Due to temporary unbalance and other factors, the torque required when starting the skip is two or three times as great as when running. A blast furnace skip hoist requires high torque at low speed and low torque at high speed.

In the past, most skip hoist drives have had inherent constant torque capacity. They have not been well suited to the load characteristics and they have not denoted the most advantageous use of the electrical equipment employed.

A new drive has been evolved in which the series-parallel connection of two motors is combined with field-forcing and field-weakening. This scheme affords a wide range of speed control, with the result that the slow-down speeds, as well as the running speed, can be secured without the use of armature circuit resistors.

The heavy armature circuit resistors employed with previous magnetic contactor controls have been objectionable because of cost, because of control complication, because of heavy currents to be handled and large power losses and because of poor speed regulation characteristics. Largely to obviate these objections the expedient of Ward-Leonard control was espoused.

The new drive has inherently an inverse torque characteristic. It employs motors, brakes, and control effectively. Minimum equipment, with minimum complication, yields adequate performance.

WELDING METALLURGY

By W. G. Theisinger
Director of Welding Research
Lukens Steel Co.
Coatesville, Pa.

The fundamentals of welding metallurgy are in general the same as those encountered by the steel mill metallurgists and the problems resulting from welding show many of the characteristics which appear in steel mill practices. Welding and steel making make use of the melting, casting, solidification and heat treatment of steel, and the variables in either process are common to both. The differences in the way these operations are conducted have like effects on the physical and service uses on the product.

However, one of the main dissimilarities is the type of "mould" that each employs. The steel maker selects a mould wall great enough in thickness so that he will prevent the adherence of his molten metal to the mould wall. The welder, on the other hand, must make certain that he does adhere firmly to his "mould", which is the base metal being joined together. In the welded fabrication of heavy plate this fact must be given special attention. Otherwise, his weld will result in failure during fabrication or service.

The metallurgist also has an opportunity to make use of alloying elements in order to obtain the desired physical properties of the deposited weld metal. This may be done by the alloy content of the electrode or to a lesser degree by the pick up of such elements from the base plate. For such uses as low temperature or high temperature service, the same alloying elements used in steel plate may be adopted for the weld, namely: nickel or molybdenum.

In the mechanics of making a welded joint, there are also combinations of elements to be avoided. For example, in the welding of clad steels care should be taken to prevent any dilution of the cladding metal into the weld of the base metal for structural reasons. In like manner, but in order to maintain the corrosion resistant properties, dilution of the base metal into the weld of the cladding should be kept to a minimum.

The stress relieving treatment is a beneficial one since it has an equalizing effect across the welded joint by reducing the stresses at this point and at the same time eliminating any harmful microscopic constituents that might cause failures in service.

ABSTRACT OF PAPER ENTITLED BEARING SURFACES

By E. L. Hemingway
Chief Metallurgist
International Machine Tool Corporation
Elkhart, Indiana

This paper describes the defects of surface which are detrimental to bearing operation. They are due to a single direction of stock removal, resulting in the formation of a helical ridge by the turning tool or grinding grit; the violent action of a tool capable of removing considerable metal, with fragmentation, annealing, production of smear metal, and possibly decarbonization as a result; and the inability of the machine tool, including grinders, to produce a sufficiently accurate geometrical shape.

The effects of these detrimental conditions, which are abrasion and galling, are described. Reasons for belief that waviness is more detrimental than grit ridges are given. Waviness exists in all surfaces, in varying depths. The depth of ridges should be sufficient that it allows complete wearing-away of waviness before they also disappear. This is a plea for production of the most perfect geometry of bearing surface shape because deep ridges also result in reduction of the effective bearing area.

The most efficient scratch pattern from the standpoint of both maximum actual bearing area and galling due to boundary lubrication conditions, is discussed. Less is known regarding this particular problem than any other concerning bearing surfaces, and it therefore offers the most interesting field for research.

ROLL OILS AND COOLANTS FOR THE COLD MILL

By Maurice Reswick
Lubrication Engineer
Standard Oil Co. of New Jersey
Pittsburgh, Pa.

All rolling operations involve two kinds of friction. First, the internal molecular friction of the steel in its resistance to deformation, and, second, the external friction of the strip against the roll surfaces. Outside of metallurgical control or annealing, nothing can be done to reduce the internal molecular friction in the metal itself, but the external friction can and must be minimized to the lowest possible value by lubrication.

The requirements of lubrication and cooling are localized in the same place at the area of contact between the strip and the rolls. For lubrication we need an oil having good film strength, but to carry away the heat we require a fluid medium having the highest possible rate of heat absorption and dissipation, which is best met by water. Two principal methods of application are in vogue. By one method the roll oil is applied directly while a stream of water is applied independently. By the other method the lubricant and the water are mixed together and the "solution" in copious quantities is re-circulated. Both systems have their adherents among cold mill operators.

The function of the coolant constituent of the "solution" or of the water, is obviously to remove the generated heat in a controlled manner and also to regulate the contour of the rolls under thermal expansion, and thus assure equal distribution of rolling pressure and evenness of gauge.

The lubricating constituent in the "solution" or roll oil has a direct effect on power consumption, prevention of pick-ups on the rolls, imparts a better finish, enables to roll at higher speeds, and the portion of the lubricant carried over acts as a rust preventive until the next process or fabrication operation.

The types of roll oils and coolants in current use on representative mills may be classed as follows:

1. Straight mineral oils in viscosities, in seconds Saybolt Universal at 100F., from 50 to 200.
2. Mineral oil compounded with animal and vegetable fats.
3. Soluble oil emulsions with water.
4. Soluble oil and palm oil emulsions.
5. Straight palm oil, heated.

The particular system used depends on the original design of the equipment, type of work done, and in a very large measure on the preferences of the mill operators. The paper discusses the characteristics of these various oils, their application, and methods of reclamation. Heretofore mill operators were not over-enthusiastic about palm oil replacement, so long as they felt that an abundant supply of palm oil was available. Under existing war conditions, with the disappearance of domestic supplies in sight, everybody concerned from the management to the mill operators is concerned about the situation, and is on the look-out for a replacement which may eventually prove better even than palm oil.

Mills using the closed circulating system for cooling and lubrication, involving not more than 5 per cent palm oil in the solution should not have a difficult problem in finding a replacement among domestically available emulsifiable fats or proprietary chemical compounds. But mills using the dual system of water for cooling and roll oil for lubrication are facing a real problem. Not the least phase of this problem is any change in procedure and application of the roll oil from the established practice. The line of least resistance is obviously a product which in its physical properties resembles that of palm oil.

Recovery of palm oil replacements of the type mentioned, which approach palm oil in their physical properties, is simpler than for 100 per cent palm oil. Being synthetic products, they do not vary in quality, and the ingredients may be chosen so that they will not undergo chemical changes in the mill to the same extent as the natural product. Essentially, all that is required is heating to settle out the water and coarse foreign particles, and centrifuging, if desired as a refinement, to remove the finer particles of mill dirt. The clarified product is then ready for re-use on the mill.

AIR BRAKE CIRCUIT BREAKERS FOR INDUSTRIAL USE

By Ralph Lockett
Application Engineer
I-T-E Circuit Breaker Co.
Philadelphia, Pa.

Steel mill engineers are most interested in circuit breakers suitable for steel mill use, and in similar apparatus used in other industries. There are many special circuit breaker applications in mills, such as direct current variable voltage drives, installed in closed rooms built for the purpose. Such applications represent a specialized field and it is the scope of this presentation to describe relatively standardized circuit breakers used in the distribution of a-c power.

Many problems connected with distributing a-c power in steel mills are similar to those encountered in industry generally.

However, many requirements for steel mill duty are unusually severe. While steel mill apparatus will be satisfactory in most other industries, the reverse is not necessarily true.

Requirements in steel mill practice:—

1. Ability to handle high short circuit currents.
2. Accessibility for inspection and maintenance.
3. Dependability in service with freedom from service interruption.

Usually short distances to prime generation units or transformer banks, or both, mean very little cushion between the source of power and circuit breakers. Both circuit breakers and bus require special consideration.

Many existing installations are built in open type switchboards to provide accessibility. However, their very openness invites entrance of dirt, rodents and unauthorized personnel. Oil filled apparatus inevitably seeps some oil which holds this dirt. Disconnect switches or bolted links are required for maintenance of this class of switchgear.

More modern construction adopted by many industries is metal enclosed drawout switchgear. In this form we have:—

1. Isolation of individual circuit.
2. Full rated interrupting ability.
3. Ease of maintenance and double disconnect devices with inherent interlock.

For many years air circuit breakers have been used almost exclusively for services up to 250 volts, but some mills had in service large numbers of oil breakers on 440 and 550 volts. Most of these oil circuit breakers are of the stationary, open type.

Present practice is to use air break circuit breakers for all 220, 440 and 550 volt applications. The principal advantages are:—

1. High speed.
2. High interrupting capacity.
3. Freedom from oil fire.
4. Accessibility for inspection (no tank).

Success in mill service and utility heavy duty work at lower voltages has lead to increasing applications for air circuit breakers for 2300, 4500 and 6600 volt service. In view of the small amount of 2300 and 4500 volt equipment used in steel mills, the 6600 volt air circuit breaker is of primary interest.

Breakers of this design are now available up to 2,500,000 kva interrupting capacity, and in the air type represent investments very little higher than that required for comparable oil circuit breakers.

Special duty air type breakers, such as the ultra-high speed devices for rectifier service, air blast transmission line breakers, etc., will be briefly discussed.

CONSERVATION OF CRITICAL MATERIALS IN TRANSFORMER DESIGN AND APPLICATION

By J. K. Hodnette
Engineering Manager
Westinghouse Electric & Mfg. Co.
Sharon, Pa.

The planned expansion of war production requires increasing the power generating and transmission capacity of the country. This, in turn, requires increasing the transformer capacity as well. The shortage of critical materials such as steel, copper and oil emphasizes the necessity of building transformer equipment with the minimum use of such critical materials. As a result of a number of developments completed in the past few years, improvements are available that save from one-fourth to one-third of the materials previously required in the building of transformers. Three major developments which have contributed largely to the reduction in materials required for building transformers are discussed in this paper. They are improvements in properties of silicon steel, loading transformers by copper temperature and forced oil cooling of power transformers.

GAUGE CONTROL IN COLD ROLLING OF STEEL STRIP

By J. D. Campbell
Industrial Engineering Dept.
General Electric Co.
Schenectady, N. Y.

On cold strip mills it is desirable to obtain as much "on-gauge" material as possible from a given coil. Usually, the "off-gauge" material from the cold mill is obtained at the extreme front and rear ends of the completed coil. Any attempt to increase the percentage "on-gauge" in a coil, therefore, should be directed at both ends of the strip while it is being reduced.

Tandem cold mills in particular usually accelerate from a relatively low threading speed to a high running speed; and near the end of the coil, the mill

is decelerated to the threading speed. Anything which happens to the extreme front and tail ends of the coil must, therefore, largely be during the transient period of acceleration and deceleration. It is the purpose of this paper to give the results of tests made on a tandem mill rolling steel of tin plate thicknesses. The aim of the tests is to quantitatively determine how much more "on-gauge" material can be rolled by automatically controlling tension during the transient periods. Results of measurements on strip speed, strip tension, and gauge will be made with the further aim of determining why the coil ends are rolled "heavy" when no attempt is made to have automatic tension control during the accelerating and decelerating time. The effect of the ultimate rolling speed on on a mill on the point of "getting gauge" (during acceleration) and "losing gauge" (during deceleration) will also be brought out.

The aforegiven results will be measured on multi-element oscilligraphs measuring the electrical outputs from tachometer generators, tensiometers, and flying micrometers.

THE APPLICATION OF MODERN COLD SAWING TECHNIQUE

By Norman A. Malone
Plant Industrial Engineer
Timken Roller Bearing Company
Steel and Tube Division
Canton, Ohio

The purpose of this paper is to present and introduce to industry an efficient and economical method of cold sawing steels vital to the manufacturing of materials for the war effort.

The increased demand for quality steel (stainless and high alloy) and the present rigidity of metallurgical inspection and requirements has made it necessary to furnish large quantities of sawed metallurgical test samples in order to determine quality.

This new demand for test cutting beyond ordinary cutting had become too great for the existing cold sawing equipment and much of it had been made obsolete through inadequacy to cope with this condition.

With this problem in mind, the writer, in May 1939, started to conduct a detailed survey in the accumulation and study of data relative to ways and means of improving the productivity of cold sawing equipment and the technique of operation.

Based on extensive specific experience, the paper will introduce some original studies and pioneering procedure on cold sawing, strictly applicable to a specially designed cold sawing machine, as derived from actual data and experience accumulated in the field. The constituents of this cold sawing method will be presented on the following bases:

1. The selection of feeds and speeds, determined on the basis of Brinell hardness and size of the section to be cut.
2. The selection of the circular saw blade in relationship to the hardness of the section to be cut.
   a. Determination of pitch and tooth form.
3. The specially designed cold saw machine and its major functions.
4. The operation and maintenance of the saw machine.
5. Saw blade sharpening technique.

THE DEVELOPMENT OF PERSONNEL IN THE STEEL INDUSTRY

By Russell J. Greenly
Industrial Relations
Carnegie-Illinois Steel Corporation
Pittsburgh, Pa.

The first step in the planning of personnel selection and development in the steel industry is to make our best estimate of local needs, then forget it and approach the problem "What can we do about it?' This question can best be answered by surveying the sources of labor supply which have been taxed in the past and which we may expect to be able to tax in the immediate future.

While the unemployed pool, the schools and young workers, the recruited workers and those workers with limited skills can all rightly be considered as possible sources of labor supply, the potentialities of these sources are not great. It is safe to say that these groups cannot be relied upon to increase steel production to meet present bogies.

If we are to plan intelligently the selection of new employes, we cannot afford to overlook labor released by industries closed due to lack of material. A second important source of labor, often overlooked, may be found among our own employes, in the form of unused skills. Upgrading in the ranks of present employes provides a definite incentive toward more productive and superior workmanship. Another source of labor supply which must be used to a greater degree in the steel industry are the females who are not now employed by our industrial system. Those in the steel industry who are saying that women cannot be used are blind to the necessity of the times. The employment of females must be planned with consideration of every element, but they must be used.

In the present effort we cannot depend on the old method of training by absorbtion. There are five basic types of training which may be used for training personnel. These are as follows: Trade extension education, apprenticeship training, job training, learner training, and supervisory training.

Training has too often been regarded as an end in itself, rather than as a means to an end. The end must be increased production, as quickly as possible. The majority of training activities should be planned on either learner training or upgrading, if production goals are to be attained.

Every effort must be made to measure the effectiveness of training. Improved production records, less

fuel consumption, reduction in waste, reduction in delays, and many other methods must be used to objectively measure the results of a training program. The old proverb might be paraphrased in this way: "The proof of the training is in improvements of production".

ELECTRICAL EQUIPMENT FOR CONTINUOUS ELECTROLYTIC TINPLATING OF STEEL STRIP

By J. H. Hopper
Industrial Engineering Dept.
General Electric Company
Schenectady, N. Y.

A brief general description will be presented, with illustrations, of each of the three general types of continuous electrolytic tinning lines which are being installed by steel companies this year. This description will include the types of electric drive and control recommended in each case.

Conversion equipment for providing the low voltage direct current used in plating will be discussed and the application of dry type rectifiers for this purpose will be covered.

A brief description will also be given of several unusual problems which were presented by the continuous tinning line, and which were solved by electric equipment of special design.

PROPERTIES OF BLAST FURNACE COKES: THEIR MEASUREMENT, SIGNIFICANCE, AND CONTROL

By H. H. Lowry and
Martin A. Mayers
Coal Research Laboratory
Carnegie Institute of Technology
Pittsburgh, Pa.

Coke quality is commonly considered to determine the efficiency and economy of blast furnace operations. There is, however, little or no agreement on what determines coke quality. An examination of various tests that are supposed to measure properties of coke will be presented, with a view to determine their reliability and precision, both as tests of real properties of the coke and as indicators of quality in performance. As a result of this examination, it is concluded that those properties which determine the contribution of the coke to the structure of the blast furnace stock column can be subjected to control which may be expected to result in more uniform operation.

The usual procedures of testing coke do not provide adequate control of these structural properties, including size, size stability, and porosity. In the evaluation of coke, the importance of reactivity and of sulphur content has probably been over-emphasized; but the former, at least, is controlled by the same factors as control the structural properties. For a given oven charge, the most important variable is the final coke temperature. This is not directly related to either flue temperature or coking time, but depends on both of them. Control of the oven charge depends not only on the controlled chemical analysis of the coal, but also on uniform physical structure, which requires control of size, size distribution, and mixing of the coal as well as controlled uniform moisture content, bulk density, and avoidance of segregation.

MODERN TURBINE TYPES AND DESIGN

By F. K. Fischer
Central Station Steam Engineer
Westinghouse Electric & Mfg. Co.
Philadelphia, Pa.

This paper reviews briefly the progress in turbine operating conditions leading up to present day practice.

Orders placed by industry in the United States in a one year period are analyzed. This gives a clear picture of the modern accepted practice as to pressure, temperature, speed, and size of turbine generators; it also illustrates trends.

Modern turbine types are described and illustrated. The application of these modern units, and their design to insure reliable operation at the high steam pressure and temperatures in common use today are described.

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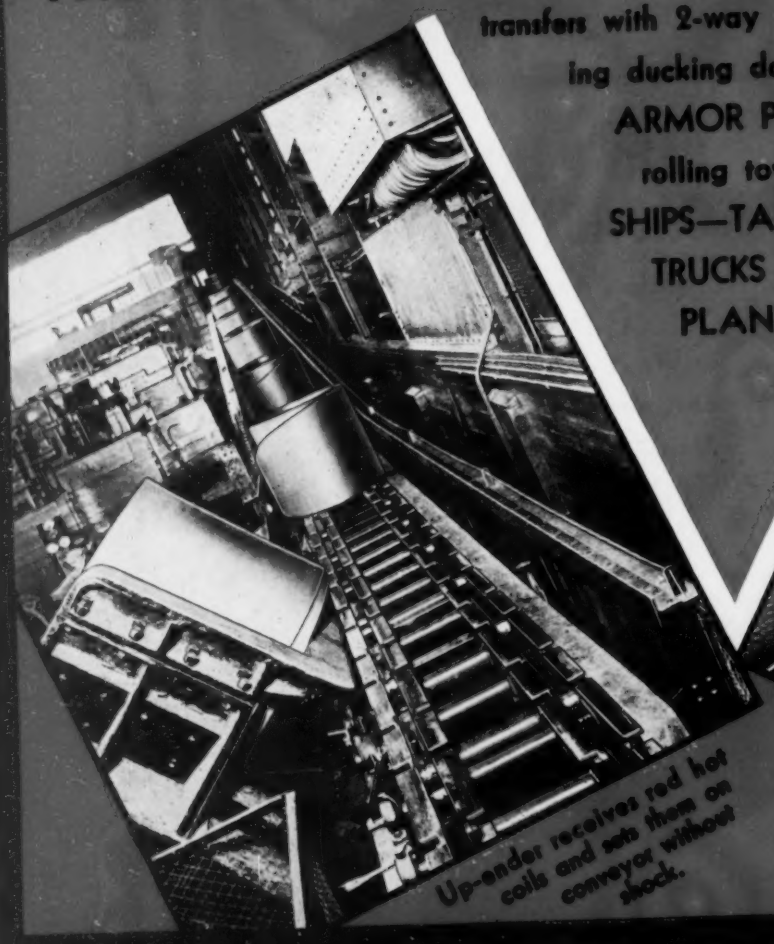

Up-ender receives red hot coils and sets them on conveyor without shock.

Plate End-Piler with run-out table in the foreground.

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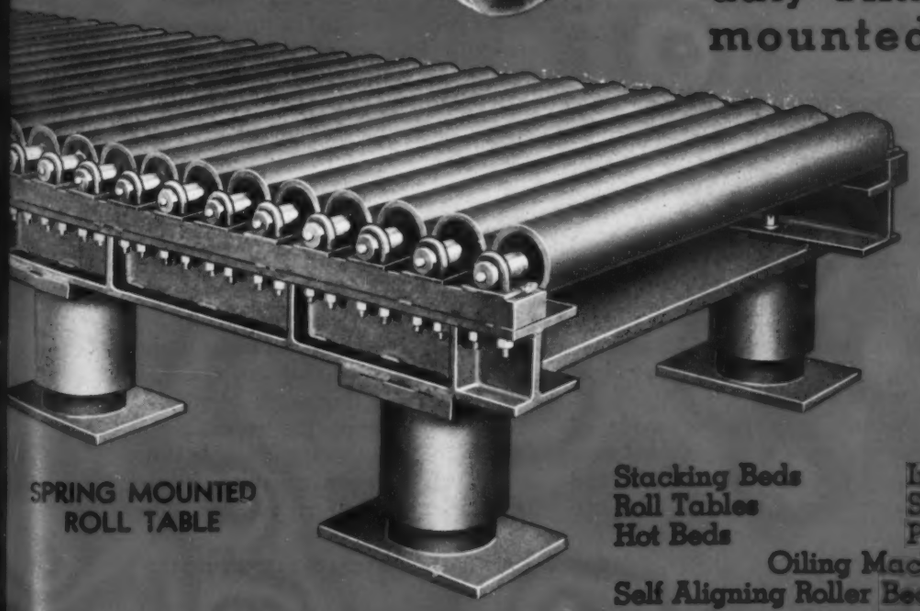

SPRING MOUNTED ROLL TABLE

ENGINEERS AND BUILDERS OF STEEL MILL EQUIPMENT:

Up-enders and Down-enders
Soaking Pit Cover Lifters
Plate Turnover Rigs

Stacking Beds
Roll Tables
Hot Beds
Inspection Tables
Slab Transfers
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Transfer Chains
Roller Conveyor
Oiling Machines
Coil Conveyors
Self Aligning Roller Bearing Pillow Blocks with Cast Steel Housings

PALMER-BEE COMPANY, DETROIT

ARMCO DEDICATES NEW BELLEFONTE FURNACE

▲ Reviving a name prominent in the annals of the steel industry of the Tri-State area, Lt. General William S. Knudsen and George M. Verity, chairman and founder of the American Rolling Mill Company, christened Armco's new Ashland blast furnace "Bellefonte" and dedicated it to the perpetuation of Christian principles and human liberties, on August 24.

The new pig producer is rated above 1,000 tons per day and is one of the largest now in operation in the United States.

The original Bellefonte was lighted in 1826 and cast its last pig in 1891. It was a small charcoal furnace.

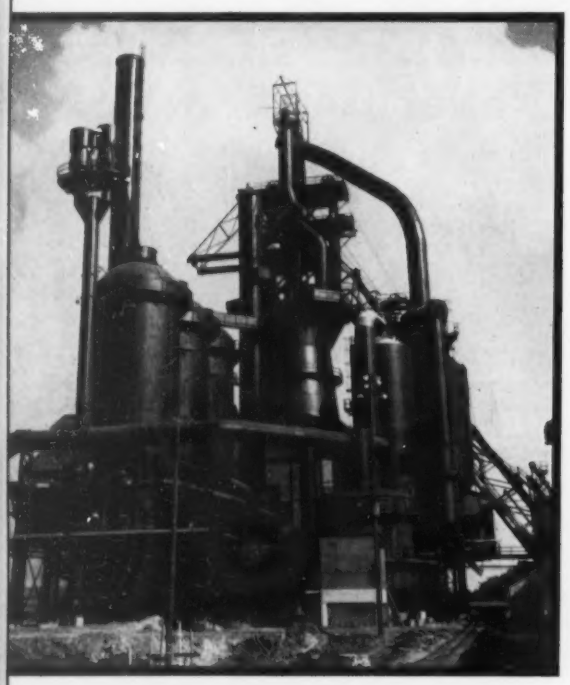
In marked contrast, New Bellefonte is as tall as a nineteen story building. More than 4,500 tons of air are pushed through it each day. Eleven thousand gallons of water are pumped to it every minute. Freight bills on material needed to keep the giant fed add up to nearly $4,000 per day. The ore yard, complete with a car dumper and traveling crane, can hold 450,000 tons. An elevator transports workers to the various levels of equipment.

Men from the Armco plant, management and representatives of the public lighted the new furnace at simple ceremonies.

Representatives of the Army, Navy, War Production Board and many prominent industrialists were guests of the Ashland Business Men's Association at dedication ceremonies.

Arthur G. McKee & Co., Cleveland, constructed the furnace.

Blown August 20th, Bellefonte furnace at Armco's Ashland plant takes its place among the large units of the country.



DEVICE FOR LOCKING TRANSFORMER BUSHING

▲Pennsylvania Transformer Company has developed an outstanding new clamping device for locking each low voltage bushing securely to the side of the tank. The stationery bushing clamp is welded to the tank wall around the opening in the tank and forms a recess for fitting the shoulder of the bushing and the cork gasket. This cork gasket is completely enclosed and protected from the weather. This assures a water tight moisture proof seal.

A second cork gasket made of vellumoid forms a cushion between the top of the porcelain shoulder and the second metal clamp. The two clamps are tightened together by means of three standard screws of bronze alloy metal. If a lineman should strip the thread in the permanent clamp, he can insert a screw and place a standard nut in back of the flange and bolt the two clamps together. There is sufficient space between the clamp and the tank wall to insert a nut and tighten it on the screw.

SEVENTH EDITION OF WELDING HANDBOOK READY

▲ Greatly enlarged, the seventh edition of the "Procedure Handbook of Arc Welding Design and Practice", just published, takes on a new significance this year. This "bible of the arc welding industry", as it is frequently called, is now playing the roll as a "manual of arms" for an ever-growing host of workmen who have turned to welding to defeat the Axis powers on the industrial front.

As pointed out in the preface to the seventh edition of the Handbook, which has gone through 23 printings, the United States started out with a handicap in the armament race with the Axis, but the odds are being met by the widespread application of welded construction to the implements of war.

The book explains more fully than ever before the various methods and techniques used in welding, with a view to speeding up welding design and engineering and to make it easier for the thousands of men in training to learn the essentials of welding in the shortest possible time.

Illustrated more exhaustively and more clearly than ever before is the

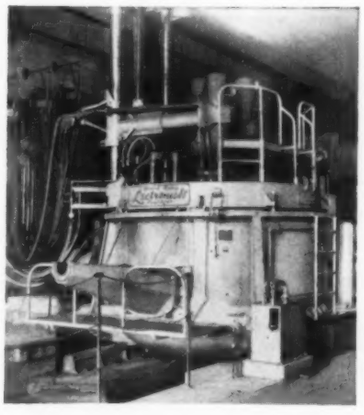
chapter on "Typical Applications of Arc Welding". Large numbers of these new applications have been developed during the past year in the many fields of war production.

The book, of 1308 pages and containing 1810 illustrations, is published by The Lincoln Electric Company, Cleveland, Ohio.

IMPROVE DESIGN OF SMALL ELECTRIC FURNACES

▲The Pittsburgh Lectromelt Furnace Corporation, 129 32nd St., Pittsburgh, Pa., has improved the design of a number of their smaller size electric furnaces in order to more efficiently handle the peculiar type of lighter scrap now being turned into the steel mills. Principal change is in the elongation of side plates to increase volumetric scrap capacity, and maintain rated capacity of heats.

A typical example of the change in design is in the ten-ton Lectromelt furnace herewith illustrated. In this



Many new features of design are incorporated in this 10-ton electric arc furnace.

size, the side walls were deepened to allow an increase of 25% in scrap capacity. The scrap capacity of two to five-ton furnaces has been increased approximately 22%. Side walls, including refractory linings average 13½" in thickness. Furnaces are cylindrical in shape with spheroidal bottoms.

In commenting upon the change in design, an executive of the Pittsburgh Lectromelt Furnace Corporation pointed out that relatively little heavy railroad scrap is being collected these days while there has been an increase in punched out sheets, shell turnings, etc., a large portion of which is not baled.

The manufacturer will be glad to furnish additional information upon request.

ELECTRONIC SEPARATOR MAY AID TIN SHORTAGE

▲ To concentrate the metallic ore containing tin and other war metals from low grade deposits, an experimental electronic ore separator has been developed at the Westinghouse Research Laboratory which extracts the ore suitable for smelting. This device has recently been demonstrated before a group of metallurgical experts, including university professors and representatives of the United States Bureau of Mines. If this separator is as efficient in actual mining operations as in laboratory tests, it can be a valuable aid in easing America's tin shortage.

Most promising results with this new Westinghouse research development, according to G. W. Penney manager of the Electro-Physics Division, have been attained with low-grade ore samples from a recently developed tin deposit in a southern state. This sample deposit containing one per cent tin separated by this device, yielded a concentration of metallic ore containing about 70% tin.

The foot-wid metal drum of the laboratory separator turned with a surface speed of 12 miles an hour, sorted in one minute the ten million particles making ten pounds of ore. Two neat piles of particles were deposited. One contained rock and sand and a small percentage of tin; the other, nearly all tin with a small amount of rock and sand.

This electrostatic separator can sort dry mixtures of any two materials provided one is fair insulator and the other has appreciable conductivity. The separation principle is similar to the attraction of iron filings to an ordinary magnet except that the attraction is electrostatic. Ore ground to the fineness of sand trickles through a trough and falls onto a rotating metal drum. Here they receive high voltage electrical charges from a series of fine wires a short distance from the drum's surface. Since the metallic particles are good conductors of electricity, the electrical charges seep through them and into the metal drum. The metal particles lose their charge and fall off before the drum has made one half turn. The poorer conducting sand and rock particles retain their charge and cling to the drum until pulled off by a series of positively charged wires during the second half revolution.

FORCED OIL COOLING ADDS TO TRANSFORMER POWER

▲ Vitally needed increases in power transformer capacities can now be obtained quickly with a new system of forced-oil cooling that saves 25% in critical war materials on new transformers, the Allis-Chalmers Manufacturing Co. has just announced. The new cooling unit, called the "Electro-Cooler," will step up capacity of transformers already in service by about 20 to 60%, the company reports.

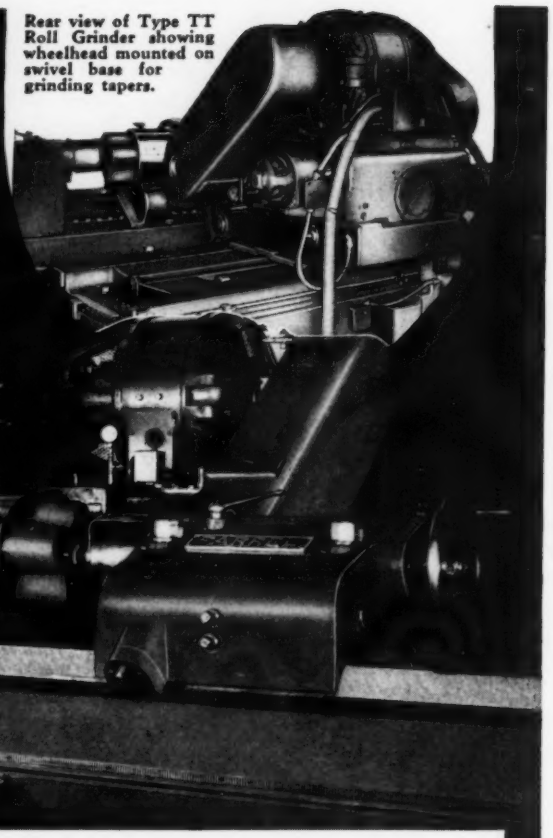
The forced-oil system of cooling transformers is made highly practical with the "Electro-Cooler," because the unit is built compact, factory-assembled and factory-tested at high pressure to minimize the possibility of future maintenance. If the transformer has radiator valves, the unit can be removed without draining the transformer oil, and parts can be replaced without delay in transformer operation.

The "Electro-Cooler" consists of a radiator-type cooler and a special pump with motor enclosed. These are connected by piping to the standard radiator valves at the side of the transformer. No stuffing boxes are required in the special pump, and the motor is self-cooled and self-lubricated.

Because the new cooling unit is relatively small, usually more than one is required, the number depending upon the size of the transformer. Greater reliability can be expected from the multiple units, since operation of one is not dependent upon the other.

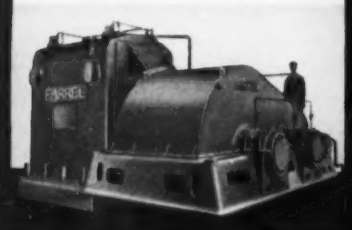
A wartime development designed to save copper and steel, the "Electro-Cooler" is expected to have wide use in post-war applications also. For the current emergency, it can not only be bult into new transformers, but can be readily applied to transformers already in service, subject to the recommendations of the trans-

FARREL TYPE TT ROLL GRINDERS....



Rear view of Type TT Roll Grinder showing wheelhead mounted on swivel base for grinding tapers.

Continuous tooth herringbone gear for rolling mill drive, 5,000 HP, weight 61,700 lbs., 145" diameter, 40" face.



Double reduction gear unit with integral 44" pinion stand for 40" x 168" reversing mill.

4,000 HP Pinion Stand for four-high reversing cold strip finishing mill.

. . . . INCREASE SPEED AND ACCURACY OF GRINDING ROLLS AND ROLL NECK TAPERS

The Farrel work-moving roll grinder, Type TT, grinds rolls of any material with high precision and with any desired finish that is obtainable with wheels at present available. Like other Farrel grinders, the Type TT is equally efficient in taking the heaviest roughing cuts or grinding the finest mirror finish. It produces rolls with flawless surface and with contours of exact symmetry and accuracy.

For grinding tapers on roll necks the new Farrel patented tapering attachment, which can be built into the Type TT grinder, offers several important advantages. This new taper grinding mechanism greatly increases the speed and accuracy of grinding roll neck tapers and facilitates the production of finished rolls with tapered necks for precision type sleeve bearings and anti-friction roller bearings.

All mechanical and electrical operating controls are within easy reach of the operator's station at the front of the machine, and they are so conveniently arranged that he has complete control of the grinding without leaving his position. He is thus able to maintain constant observation of the work and instant control of the machine to effect any operating change that may be necessary.

The traveling table drive is designed to secure positive, vibrationless traverse, steady travel and smooth, accurate reverse. Once set the traverse and reversal of the traveling table are automatic.

Many other features also contribute to the low-cost, high-output, high-accuracy performance of the Farrel Type TT Roll Grinder. Send for copy of new bulletin No. 113 giving full details.

GEARS AND GEAR UNITS

At the left are illustrated typical Farrel-Sykes Gears and Gear Units designed especially for rolling mill service. They provide smooth, quiet, uniform transmission of power and give unfailing, efficient performance under the severest operating conditions.

FARREL DRIVES *for* VICTORY

FARREL

FARREL-BIRMINGHAM COMPANY, Inc.

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former manufacturer. If the transformers are equipped with the conventional type radiator valves, installation can be made in three to four hours without even removing the oil in the transformer.

Since the application of the "Electro-Cooler" avoids the necessity of adding new transformer units, it is considered a much-needed solution to the wartime problem of overloading transformer banks.

RELINE GARY FURNACE IN RECORD TIME

▲ The Gary, Indiana, Works of Carnegie-Illinois Steel Corporation, United States Steel Corporation subsidiary, which has broken production records consistently in the war effort, scored another achievement for the American steel industry when it set recently a new mark in relining a blast furnace.

Operation of the blast furnace was resumed after a record relining time of 21 days, 3 hours and 50 minutes. The relining of the Gary furnace was from the mantle up, and the elapsed time required between the last cast of iron preceding the repair period and the first cast of the new iron production campaign was less than 22 days.

The return of this furnace to production enables the plant to operate 11 of its 12 blast furnaces. The twelfth is inactive for relining and improvement.

Except for two weeks when the rate dipped slightly, the plant has operated at 100 per cent or more of capacity since Pearl Harbor.

SHEET & TUBE SAVES 90 DAYS IN CONSTRUCTING FURNACE

▲In order to avoid losing approximately 90 days production of pig iron, so important in the current production drive, the Youngstown Sheet and Tube Company, at their Campbell plant, used an original and unique method of construction for a new 1050 ton blast furnace. The new furnace replaces an old 750 ton unit which was built in 1913 and which was kept in operation up to July 5th, 1942. In June, 112 ft. away, construction was begun on the new furnace, using a specially constructed undercarriage as a base to support the new structure. On August 19th, the old furnace having been dismantled, the new shell, complete from mantle ring up to and including the superstructure, was moved on rollers, to its proper position over a specially constructed track. Foundations had been revamped to suit the new unit, and the shell, weighing about 600 tons, was lowered upon the seven new columns. Thus, it became possible to start lining the stack almost immediately.

It is estimated that the new furnace will be ready to go back into operation by October 1st, giving a period of less than three months outage from production as compared to about six months for regular construction procedure.

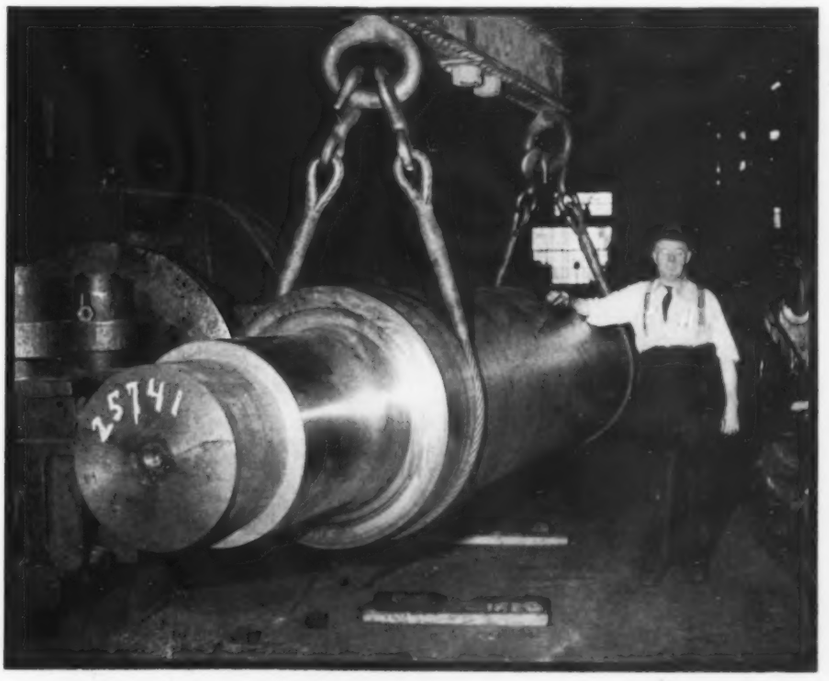
When completed, the furnace will have a hearth diameter of 23 ft., a bosh diameter of 26 ft. 6 in., and a stockline diameter of 19 ft., and will be blown through 14 tuyeres. Cubical content will be 37,583 cu. ft., and the shaft will be 100 ft. high.

Various furnace auxiliaries were rebuilt or rehabilitated. A new double skip, of 20,000 lb. capacity, replaces the old single skip. New bins, gates, stockhouse and skip house were constructed ,and the four old stove shells were relined with McKee checkers, increasing the heating surface to 120,000 sq. ft. each. New downcomers, bustle pipe, etc. were necessary, and new gas cleaning equipment was also installed.

By building this new blast furnace on a special undercarriage, the loss of 90 days of pig iron production was avoided.

Lewis Foundry and Machine has turned out rolls used in the production of armament steel for three wars. Shown here is a 36 in. x 134 in. Lewis Superior X plate mill roll produced at the Lewis roll shop, where other plate mill rolls ranging 27 in. x 160 in. to 34 in. x 206 in. are in process.

BUD SCOTT PHOTO



AETNA-STANDARD AWARDED ARMY-NAVY "E" PENNANT

▲ The Nation's highest industrial tribute — the Army-Navy "E" banner — was bestowed upon management and employes of the Aetna-Standard Engineering Company, at Ellwood City, Pennsylvania, August 31, in recognition of meritorious work which they have performed in the interest of national defense.

In presenting the award, Brig. Gen. H. C. Minton, district chief, Pittsburgh ordnance district, said, "we have just reason to be proud of what has been accomplished during the first nine months of the war, but the fact remains that we have just started to take the initiative."

He emphasized that we are going to bomb Tokio and Berlin and we are going to have more battles like Midway, Coral Sea and the Solomon Islands. Turning to the employes attending the ceremony, he said you may feel that no one cares whether you produce or not. But when you feel like that go out and take a look at this Army-Navy production pennant flying above your plant and remember it was placed there in recognition of the fact that you did a good job of designing and producing munitions for your country and allies and that the war is not yet over. Remember, that you are all soldiers on the production line of freedom and that what you are doing for America is being done voluntarily and freely without regimentation or coercion.

The award was accepted by E. E. Swartswelter, president of the company.

Three distinguished workers of the company whose years of service total 110 years, were the first employes to be presented with the Army-Navy production award pin. These were L. Kistner, foreman of the toolroom, 38 years' service; Charles Hazen, toolroom employe, 36 years' service; and John Vogler, plant guard, 36 years' service.

Over 300 employes were present at the ceremony which was broadcast over station WKBN, Youngstown, Ohio.

Army-Navy "E" pennant being bestowed to management and employes of the Aetna-Standard Engineering Company. Award was presented by Brig. Gen. H. C. Minton, district chief, Pittsburgh Ordnance District, left, and was accepted by E. E. Swartswelter, president, Aetna-Standard, center, and by J. D. Francosky, SWOC representative, right.

TWO-FOLD PROGRAM WILL CONSERVE ELECTRICAL MATERIAL

▲ The material allotment to the electric motor and control industry has made it necessary for the Electric Motor and Control Section of the War Production Board to recommend and initiate a twofold program to conserve critical materials. This program consists of the utilization of full service factor of electrical equipment, and design simplification, along with extensive use of secondhand electric motors and control.

There is an ample supply of used or secondhand standard electric motors and control available in dealer's hands and, particularly, in many manufacturing plants, according to information made available. Since approxi mately 90 per cent of this industry is tagged for the armed services and the most vital war plants, deliveries on all but the most vital orders are quite long, and sometimes impossible. The use of secondhand motors would effect immediate delivery as well as the saving of critical materials. It will require considerable vigor, imagination and ingenuity on the part of the user in order to locate and adapt secondhand equipment. If the operator cannot locate secondhand equipment by his own efforts, he may fill out, sign, and forward a standard form, and the Electric Motor and Control Section will assist him in attempting to locate suitable equipment.

Electric motor manufacturers have received no conclusive evidence of overloading motors on the part of operators. It has been stated that motors today do not break down because of overheating resulting from overloading, but rather because of mechanical failure.

Therefore, where new electric motors and control are required because of their special characteristics, it is suggested that all purchasing agents, engineers, architects and consultants, who will be concerned with the operation or design, or application of electric motors and control, follow out, to the best of their ability, the following recommendations:

1. In applying motors, determine with maximum possible accuracy the horsepower required. This should be preferably obtained by test or, in the event that this is impossible, by accurate calculation, or by careful comparison with known power requirements of similar apparatus.
2. When applying open type, a-c

continuous rated 40 C motors where the motor rated voltage is maintained and where the ambient temperature is usually substantially below 40 C and will only occasionally, or for short periods equal or slightly exceed 40 C, select the standard horsepower rating which is not substantially more than 80 per cent of the horsepower determined in accordance with recommendation No. 1.

Example: The required horsepower, as determined in Paragraph 1, is 9.3 horsepower; 80 per cent of 9.3 equals 7.44, so select a standard 7.5 horsepower motor.

3. When applying a motor, a-c or d-c, rated on a 50 C or 55 C basis, where the motor rated voltage is maintained and where the ambient temperature is usually substantially below 40 C and will only occasionally or for short periods equal or slightly exceed 40 C, select the standard horsepower rating which is not substantially more than 91 per cent of the horsepower determined in accordance with recommendation No. 1.
4. After selecting a motor in accordance with recommendations 2 and 3, torque and operating speed should be checked to assure their tendency.
5. When applying an open type continuous rated 40 C d-c motor in a location where the ambient temperature is usually substantially below 40 C and will only occasionally or for short periods equal or slightly exceed 40 C, select the standard horsepower rating which is at least 87 per cent of the horsepower determined in accordance with recommendation No. 1.

The type of motor selected shall be of the simplest mechanical and electrical design, which can be used to economically accomplish the purpose for which the motor is purchased. Where operating conditions permit, the following specifications should be adhered to:

1. Open type motors rather than protected motors.
2. Motors of high speed instead of low speed.
3. Single speed rather than multispeed motors.
4. Single winding rather than two-winding where multispeed motors are essential.
5. Alternating current instead of direct current motors where alternating power is available.
6. Squirrel cage instead of slip ring motors.
7. Single voltage motors only should be specified.
8. D-c adjustable speed motors should have a lesser speed range than formerly used.

1. The wiring of all controllers should be specified as following the shortest possible route consistent with the avoidance of electrical and mechanical interferences. This will result in approximately 30 per cent reduction in the amount of copper wire used.
2. When controllers are built to order for a specified horsepower, buses, terminals and wiring should not be specified in a size larger than the minimum required by the application for which the controller is designed.
3. No controllers should be specified of a capacity in excess of the

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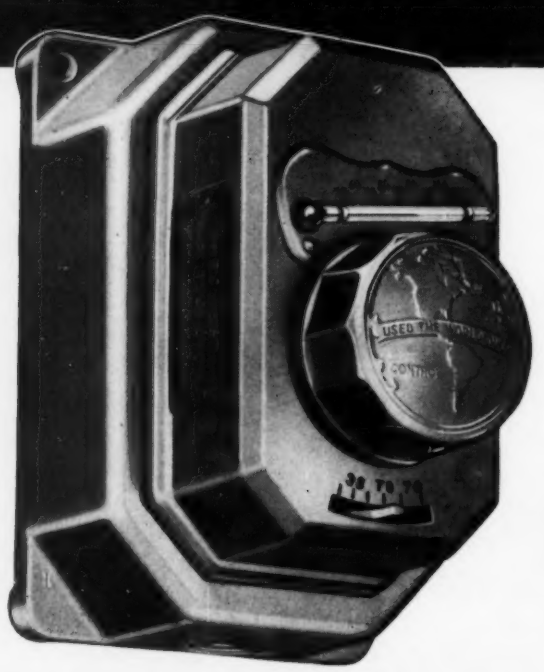
minimum required for the application.

4. No equipment or device should be specified for a controller which can be eliminated without causing severe operating hazards. This equipment includes indicating lamps, special nameplates, instruments, test receptacles and jacks, extra terminals, special locks, items for the improvement of appearance, etc. If specifications are cut to the minimum for successful operation, many tons of critical material will be saved.
5. Control circuit wiring should not be specified in a size larger than the minimum required to carry the current and to insure reliable and safe operations.
6. Controllers should not be specified with finishes which contain critical materials unless these finishes are absolutely necessary to maintain operation of the controller.
7. Color coding of controller wiring should not be specified, unless absolutely necessary. Color coding specifications force manufacturers to carry larger stocks of wire than would be necessary if one color wire were used.
8. Control circuit transformers should not be specified, unless the line voltage is higher than 600 volts, or unless suitable pilot devices of adequate voltage rating are not available.
9. Control circuit fuses should not be specified if the control transformers have less than a 2200 volt primary winding or if the control circuit is direct current.
10. Where full voltage starters are available, and, if motor design will permit, reduced voltage starters should not be specified, unless torque must be limited, or if system capacity makes full voltage starting impossible.
11. If manual controllers of suitable ratings are available, magnetic controllers should not be used, except where pilot devices are essential to the operation controlled or where lack of undervoltage protection would result in definite danger to human life.

1. For new plants or extensions the utilization voltage should be restricted to 440 volts a-c, except where motors 100 horsepower and larger are used, in which case the voltage should be 2200 volts or more.
2. No auxiliary or reserve buses or their attendant equipment should be provided.
3. Network distribution systems should not be used unless they show an over-all saving in critical material.
4. No equipment of any kind should be installed to provide for future loads or extensions.
5. No duplicate feeds or loop feeds should be used if any appreciable amount of material is required above that necessary for a single radial feeder.
6. All buses and feeders should be tapered as to size where long runs are used with loads being taken off along the run.
7. Requirements should in all cases be based on demands after load factor is considered and all equipment specified so it will be loaded as near nameplate rating as possible.
1. No electric motor and control should be purchased for any use

CROUSE-HINDS
Type FHRC
Thermostat Condulets



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unless reasonable effort has been made to obtain used or second-hand equipment, unless the maximum number of shifts are used, or unless reasonable effort has been made to adapt idle equipment in the possession of the user to the application.

2. No electric motor and control should be purchased for replacement of existing equipment for reasons of breakdown, damage, or obsolescence, unless reasonable effort is made to keep equipment in operating condition by installation of renewal parts or a reasonable amount of maintenance work.
3. No electric motor or control should be purchased in a size larger or of more complex design and construction than is required by the minimum operating conditions.

INSULATING VARNISH FOR HIGH TEMPERATURE JOBS

▲ The Sterling Varnish Company, 144 Ohio River Boulevard, Haysville, Pennsylvania, has recently developed a new insulating varnish, designated as S-110, for application to electrical apparatus that must operate at abnormally high temperatures. Tests have indicated that S-110 will stand operating temperatures at 250 C or higher.

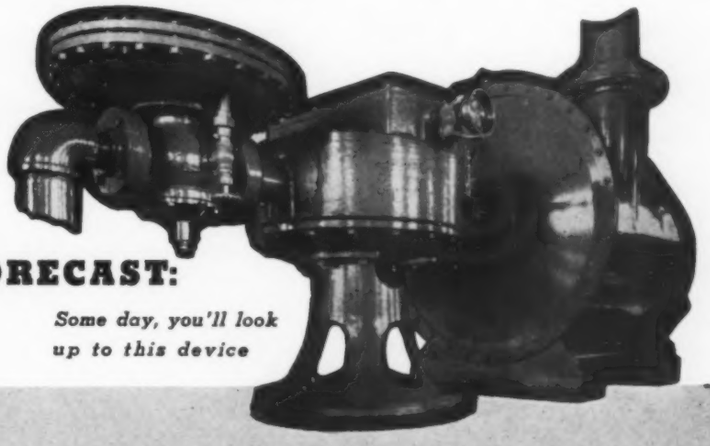
When baked at 175-200 C it dries all the way through the deepest winding and does not resoften when exposed to high operating temperatures. The dried film is mechanically strong, exceptionally adhesive and flexible, and retains these characteristics under adverse heat conditions.

The experience of one motor manufacturer confirms the unusual operating efficiency of Sterling S-110 insulating varnish at abnormally high temperatures.

A machine had been wound with glass covered wire and insulated with glass and mica, after which it was treated with two coats of S-110. The machine was then run to destruction. Upon investigation, the insulation varnish was found to be in excellent condition and the stator showed no signs whatever of breakdown even though the rotor bars had loosened due to the brazing having melted away. The brazing material in question melts at 700-800 C. The insulation test on the stator was perfect.

Available Literature

▲ Power circuit transformers are described in the new Bulletin 421-PCT just prepared for distribution by the Jefferson Electric Company of Bellwood, Illinois. This bulletin describes the uses of dry-type power circuit transformers, and by means of circuit diagrams shows how electrical installations for lighting and power can be simplified, how copper and conduit are saved. These transformers are for mounting on wall or post or directly on a machine, no enclosure being required. All the data are included for the double-wound transformers in sizes from .05 to 15.0 kva output and for auto transformers in sizes from .05 to 25.0.



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KEMP of BALTIMORE

▲Allis-Chalmers Manufacturing Company announces the publication of an entirely new kind of maintenance handbook — "A Guide to War time Care of Electric Motors."

According to the company, the times demand a fresh approach to problems of motor care. Increase in the average motor's working time from 1800 to 8700 hours a year is cited.

Other new factors noted are the importance of continuous motor operation to the war effort, increasing difficulty of obtaining new motors, and the lack of previous experience with electric motors on the part of the thousands and thousands of new workers now being pressed into service in war production plants.

Unlike most maintenance books, "A Guide to Wartime Care of Electric Motors" applies to all makes of standard, general-purpose motors. It contains no advertising.

To clarify the overall problem of motor care, this new handbook treats separately each factor opposing long and trouble-free motor life. Thus the heading to the first section is — "Electric Motor Enemy No. 1 . . . DUST."

Other enemies, considered in turn, are moisture, stray oil, friction, vibration, misalignment, uneven wear, overload, and underload.

Last section of the booklet is a "Quick Diagnosis of Motor Ailments," broken down into symptoms you can see, can feel, can hear. Possible causes and cures appear beside each symptom.

To make the aims and methods of motor care crystal-clear to the tyro and interesting to the old hand, "A Guide to Wartime Care of Electric Motors" is filled with idea-pictures drawn in cartoon style. Thus Allis-Chalmers hopes it will prove particularly valuable for training new employees — a major problem in many plants.

Copies of this new book are free. Allis-Chalmers announces it will mail "A Guide to Wartime Care of Electric Motors" free of charge to any executive, engineer, or maintenance man sending in for it on his company letterhead. Address Allis-Chalmers Manufacturing Company, Advertising Department, Milwaukee, Wisconsin.

▲ A new 4-page booklet on the application of ignitron rectifiers for steel mill service is announced by the Westinghouse Electric and Manufacturing Company.

The new booklet briefly describes the ignitron rectifier and outlines its particular applications to steel mills. These units provide a quiet, efficient, dependable method of steel mill power conversion. They are more efficient than the old multi-anode tank type mercury arc rectifiers and in most applications are more efficient than rotating conversion equipment. There are no large rotating parts to require periodic maintenance and replacement; they are quiet in operation; and will withstand heavy overload and repeated short circuits without increasing maintenance.

Ignitron rectifiers cut steel mill operating costs, as they are light in weight and easily installed without a costly special foundation. They are highly efficient over the entire load range.

A copy of B-3129 "Ignitron Rectifiers for Steel Mill Service" or the 40-page book "Westinghouse Ignitron Rectifiers" may be secured from department 7-N-20, Westinghouse Electric and Manufacturing Company.

BETTER RESULTS IN FURNACE OPERATION with HAYS INSTRUMENTS

SUPERSENSITIVE DRAFT RECORDERS SERIES "OT" You can make sure of BALANCED Draft Conditions in Open Hearths, Soaking Pits, Annealing Furnaces and Slag Mills by installing Hays Series OT Recorders.

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This newest Hays instrument is a guide to higher manufacturing efficiency, increased production, better products and lower costs. It shows relations at a glance and eliminates the necessity of making calculations to determine excess or deficiency.

If you will write us, stating the conditions, we will tell you exactly how the Hays Visio-Ratio Gage can be applied to your problem.

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MICHIGAN CITY, INDIANA, U.S.A.

ARMY AND NAVY HONOR YOUNGSTOWN PLANT OF UNITED

▲ Presentation of the Army-Navy production award for outstanding achievement in the manufacture of war material, to the employes and management of the United Engineering and Foundry Company's Youngstown, Ohio plant, was made on September 10, in Youngstown.

The presentation of the Army-Navy "E" Flag to fly above the company's plant was made on behalf of the Navy by Lieutenant F. W. Crook, USN; and on behalf of the Army by Lieutenant-Colonel T. H. Eickhoff, War Department, Cleveland ordnance district.

The flag was received on behalf of United Engineering and Foundry Company by F. C. Biggert, Vice President of the company.

In addition to the award of the "E" flag, a lapel pin, symbol of production leadership, was presented to each of the company's Youngstown employes. The pins were received on behalf of the employes by Alonzo Stevens and Joseph Grady.

Work in all the Youngstown plants of the company stopped for 1½ hours from 3:30 to 5:00 p.m. so that the employes could attend the ceremonies which took place in the plant. Wives of employes and more than 500 other guests were in attendance.

The speakers at the ceremonies were Congressman Michael J. Kirwan of the 19th district of Ohio, T. Lamar Jackson, of the Youngstown Chamber of Commerce, and Mr. Biggert.

Commenting on the long history of United Engineering and Foundry Company, one of the world's leading builders of mill machinery, one of the company officials said:

"The company, which was incorporated in 1901, devoted the productive efforts of its various plants to the manufacture of armament equipment for the United States in World War I.

"At the outset of the Defense program in 1940, the company began the building of large forging presses for the production of armor plate for the government, as well as other presses for gun forgings, ship shafting and miscellaneous war emergency requirements.

"In addition, United Engineering undertook a large program of production of rolling mill and finishing equipment for aluminum sheets, sections and forgings, as well as large mill installations for steel plate rolling for the U. S. Maritime Commission and the Bureau of Ships.

"At the present time, the entire productive facilities of United Engineering in its plants at Youngstown, Vandergrift, Pittsburgh and Canton are being utilized for war emergency requirements."

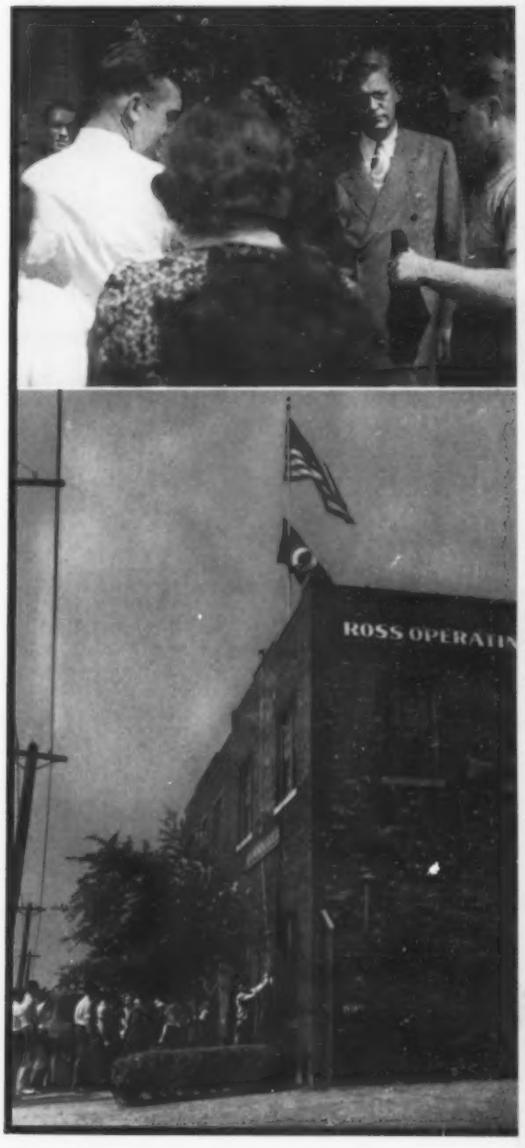
Lieutenant F. W. Crook, U. S. N., awards E insignia to Alonzo Stevens, Wm. H. Edwards, Joseph Grady and Michael Flannery, United employees with a total of 160 years of service.

BUD SCOTT PHOTO

ROSS AWARDED BULL'S-EYE FLAG

▲ A Treasury department "Bull's-Eye Flag" was raised at the Ross Operating Valve Company plant in Detroit on the afternoon of August 20th, at which G. M. Bowen, president, gave a brief informal talk to employees and guests. This is one of a limited number of such flags which has been awarded to plants where 10 per cent or more of the company's total payroll goes toward the purchase of War savings bonds. At the Ross plant where there are some 80 or more employees, 12 per cent of the total payroll including officials' salaries are now being invested in War savings bonds.

BUD SCOTT PHOTO



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ARE JUST WHAT THE NAME IMPLIES

TWENTY SIX YEARS IN THE MANUFACTURE OF MOTOR AND GENERATOR BRUSHES, ONLY, HAVE DEVELOPED A TECHNIQUE WHICH CAN BE ACCOMPLISHED IN NO BETTER WAY THAN EXPERIENCE.

DIRECT CURRENT MOTORS ARE NO BETTER ELECTRICALLY THAN THEIR BRUSHES. THE EFFICIENCY OF YOUR MOTORS OR GENERATORS CAN BE MATERIALLY LOWERED THROUGH INCORRECT APPLICATION.

IF YOU HAVE A PROBLEM WRITE OUR ENGINEERING DEPARTMENT. WE WILL NOT ONLY SEND YOU BRUSH DATA SHEETS BUT ALSO SEND AN ENGINEER **TO YOUR PLANT** TO ANALYZE YOUR BRUSH PROBLEMS. ALL BRUSHES REQUIRING INSULATED SHUNTS ARE INSULATED WITH FIBRE GLASS SLEEVING.

SUPERIOR CARBON PRODUCTS, INC.

9115 GEORGE AVENUE, CLEVELAND, OHIO

NEW YORK • BOSTON • ST. LOUIS • ST. JOSEPH • HOUSTON

Make

IMO

part of your machine

The De Laval-IMO Oil Pump

can be built into your machine and can be connected directly to a high speed member of the machine served. There are no valves, no separate bearings, no gears and no packings. Sounds simple, doesn't it?

Ask for Catalog 1-86

IMO PUMP DIVISION

of the De Laval Steam Turbine Company

Trenton, New Jersey

Wapakoneta

THE WAPAKONETA MACHINE CO.

Incorporated 1891 — Wapakoneta, Ohio.

HEAVY STEEL BLOCKS

CUT 8 TIMES FASTER

Forward speeds of about 1½" per minute were obtained on this 27" thick hot top.

...by entirely new MACHINE GAS CUTTING TECHNIQUE

Hot tops — usually full of pockets, bricks and other non-ferrous materials — and rejected heavy steel ingots have long presented a difficult cutting problem. The job of reducing these heavy masses to charging box size has always been a slow, laborious process.

Could the oxyacetylene flame be used to speed this operation? This was a problem recently assigned to our Applied Engineering and our Research Departments by one of our customers. The result was an entirely new machine gas cutting technique.

This new technique utilizes a special Airco machine with an oscillating torch movement designed to cut kerfs up to 1½" wide. This enables the cutting oxygen stream to retain its cut when impurities or blow holes are encountered. Ingots 32" thick have been successfully cut at a forward speed of about 1" per minute — approximately 8 times faster than with former methods.

This special flame cutting machine is another development made possible by the teamwork of Airco engineers and our customers — each contributing their specialized knowledge towards one common objective.

Air Reduction's wartime policy is to help American industry do the tough job we all face. Our nationwide field engineering service and our research facilities are at your disposal to supply "know how" information on any problem involving the use of the oxyacetylene flame and the electric arc.

AIR REDUCTION

General Offices: **60 EAST 42nd ST., NEW YORK, N. Y.**

IN TEXAS

MAGNOLIA-AIRCO GAS PRODUCTS CO.

General Offices: **HOUSTON, TEXAS**

OFFICES IN ALL PRINCIPAL CITIES

IDLE CYLINDERS ARE PRODUCTION SLACKERS: KEEP 'EM ROLLING FOR VICTORY!

ITEMS OF INTEREST

W. J. Reagan has been appointed as melt shop research metallurgist with the Copperweld Steel Company in Warren, Ohio.

Mr. Reagan was previously connected with the Edgewater Steel Company and is past chairman of the Pittsburgh Chapter of the A.M.S. and is at present vice-chairman of the Iron and Steel Division of the A.I.M.E.

Karl Landgrebe, vice-president in charge of administrative and special duties for the Tennessee Coal, Iron, and Railroad Company and employed by T.C.I. for more than 32 years, retired recently.

A native of Cleveland, Ohio, Mr. Landgrebe attended the Case School of Applied Science in Cleveland, being graduated in 1898. After working in Cleveland and with the blast furnace departments of steel companies in Chicago, Toledo, Ohio, and Bethlehem, Pa., he joined the Tennessee Company in 1910 as superintendent of the blast furnace department at the Ensley Works.

Successive promotions brought him the positions of assistant general superintendent at the Ensley Works, general superintendent of the same works, vice-president in charge of operations and his latest post, which he has held since 1935.

Albert S. Glossbrenner has been appointed superintendent of the Brier Hill plant of the Youngstown Sheet and Tube Company. Mr. Glossbrenner succeeds Clifton W. Edwards who died recently. The appointment was made effective September 1.

Mr. Glossbrenner attended the University of Wisconsin and became interested in the steel industry about 13 years ago when he entered the employ of the old Illinois Steel Company, one of the predecessors of Carnegie-Illinois Steel Corporation at the Gary, Indiana, tinplate plant. He then transferred to the South Works of the same company, at Chicago, as assistant foreman. He came to The Youngstown Sheet and Tube Company in February, 1935, as assistant superintendent of the hot strip mill, about two years later becoming superintendent, which position he held until his appointment to his present position.

John S. Stanier has been appointed superintendent of the hot and cold strip mills of the Youngstown Sheet and Tube Company located at the Campbell plants of the Company. Mr. Stanier succeeds Albert S. Glossbrenner whose appointment as superintendent of Youngstown Brier Hill plant was made concurrently.

Mr. Stanier's association with the steel industry began in 1912 with vacation employment at the West Penn Steel Company, Breckenridge, Pa. In 1917 he entered Lehigh University, but left to join the army, where he served with the 11th Field Artillery, 6th Division, for 18 months during World War I.

After the war he re-entered Lehigh, graduating in 1923. In 1924 he served as night superintendent of the West Penn Steel Company and was made metallurgist the following year. From this position he was made assistant general manager.

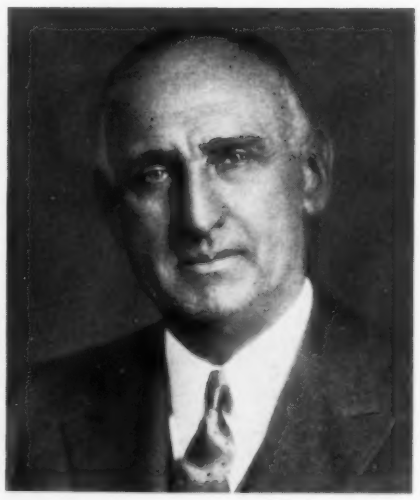
In 1928 he joined the Newton Steel Company of Newton Falls as special mill representative and later was appointed assistant to the vice president in charge of operations. In 1933 he came with The Youngstown Sheet and Tube Company as superintendent of sheet mills at the Brier Hill plant, which position he held until his appointment as superintendent of the cold strip mill at the Campbell plant. In November 1936 he was appointed superintendent of the cold strip and sheet mills.

William V. Brandt, for many years manager of the motive power battery sales division of The Electric Storage Battery Company in Philadelphia, has re-

W. J. REAGAN

A. S. GLOSSBRENNER

KARL LANDGREBE



JOHN S. STANIER

entered the United States Navy with the rank of Lieutenant Commander.

Mr. Brandt, who attended the U. S. Naval Academy, served in the United States Navy in the last war, both in submarine and transport service.

J. C. Moore, who is also an Annapolis man, formerly connected with that company's Pittsburgh branch is now in charge of the motive power battery sales division.

J. Carlisle MacDonald, assistant to the chairman, United States Steel Corp., New York, has been appointed a member of the American Industries Salvage Committee, New York, as alternate for Charles R. Hook, president, American Rolling Mill Co., Middletown, O., who is now in England.

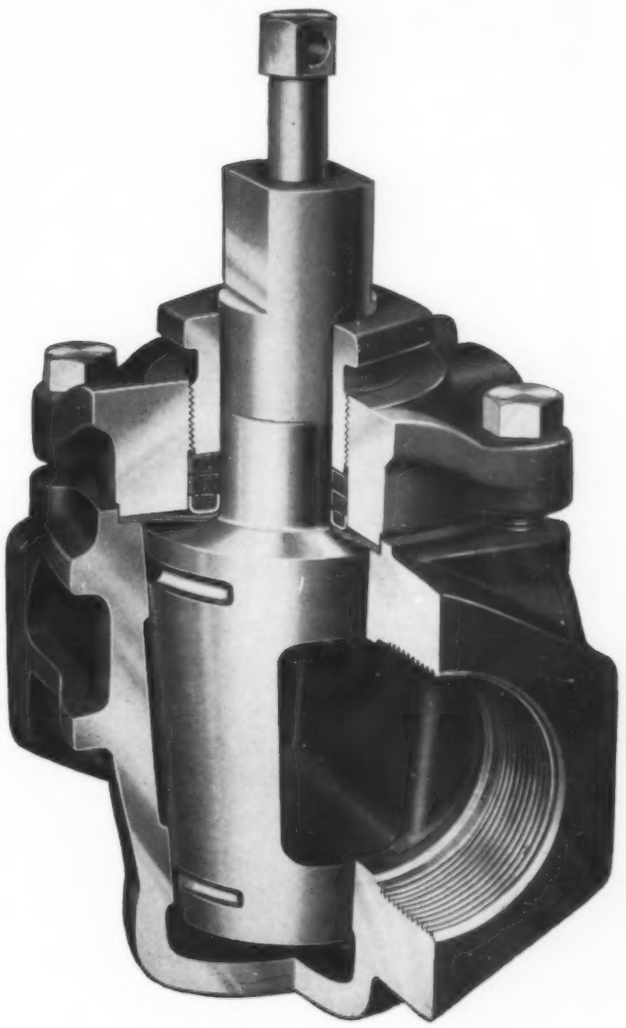
George H. Kauffeld, Jr., Pittsburgh Manager, Industrial Division, De Laval Sales and Service, Inc., New York, as well as the Pittsburgh representative of the De Laval Separator Company, New York City, has taken over new quarters comprising a two-story building located at 2040 West Liberty Avenue, Pittsburgh, Pennsylvania.

The increased space of the new quarters will permit expansion of facilities to design and produce centralized pressure lubrication equipment and special oil handling and oil reclamation processes now vitally essential to the war effort.

William H. Baltzell, retired steel company executive, died in Pittsburgh, Pennsylvania, September 2nd, after a brief illness. Mr. Baltzell was born in Dela Mere, Maryland and entered the steel business as chief engineer for the old Schoenberger works in Pittsburgh, retaining the position after the plant was merged with the American Steel and Wire Company. As chief engineer of the latter company, he supervised construction of the Donora plant.

He was also chief engineer of the construction of Midland works of the Pittsburgh Crucible Steel Company. After World War I, during which he was attached to the Carnegie Chemical works, he was named chief engineer for the Canadian Steel Corporation, a subsidiary of the United States Steel Corporation, and held this position for 22 years until his retirement in 1938. He was a member of the Association of Iron and Steel Engineers since 1919.

This valve keeps any flow line sealed against leakage —it's lubricated!



You can apply a Nordstrom Valve to any service on your lines, with assurance of permanently satisfactory performance, *because it is lubricated.* It's the safest valve because lubricant, under hydraulic pressure, seals the ports. In steel plants Nordstrom Valves are used extensively on gas and coke lines, chemical lines and air lines. Sizes ½" to 30". Ask for Bulletins.

MERCO NORDSTROM VALVE CO.

A Subsidiary of Pittsburgh Equitable Meter Co.

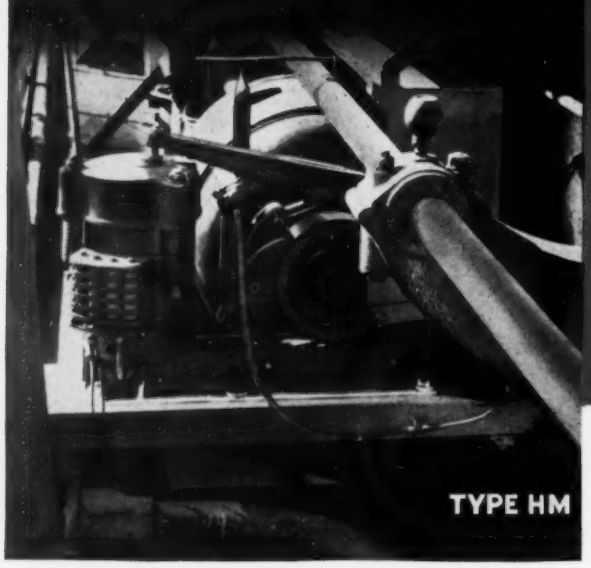
Main Office: 400 Lexington Avenue, Pittsburgh, Penna.

Branch Offices in Principal Cities

NORDSTROM LUBRICATED VALVES

Are You Buying New Cranes?

IF SO — Specify COMPLETE WAGNER HYDRAULIC BRIDGE BRAKING SYSTEMS



The Wagner Hydraulic Bridge Braking System is complete in every detail. It comes to you ready to install, and includes everything necessary — brake assembly, brake wheel, master cylinder, wheel cylinder, copper tubing, flexible hose, brake fluid and all fittings. The system is easy to install and any brake maintenance man can make the installation.

The Wagner Hydraulic Bridge Braking System assures positive braking action, smooth stopping, and controllable deceleration, to all types of overhead and whirler cranes. It will pay you to investigate if you are planning on new cranes or conversion from mechanical brakes.

BRAKE ASSEMBLY

Type H for inside cranes and type HM, where parking brake is necessary, for outside cranes.

BRAKE WHEEL

Furnished with bore as specified.

HYDRAULIC PARTS AND FLUID

All hydraulic parts and fluid needed for installation.

Write For Complete Literature

Bulletin IU-20 contains complete design, installation, adjustment, and service information on Wagner Hydraulic Bridge Braking Systems. This valuable bulletin should be in the hands of all design, production, safety, and maintenance engineers . . . Write for your copy today.

MAIL COUPON TODAY

Wagner Electric Corporation 142-3 I&SE

6400 Plymouth Avenue. Saint Louis. Mo. U.S.A.

Gentlemen:

Please send me my copy of ☐ Bulletin IU-20 on Wagner Hydraulic Bridge Braking Systems, ☐ and place my name on the list to receive the Wagner Brake-O-Gram (a periodical bulletin on the operation, care, and maintenance of bridge brakes.)

*Name*_____ *Position*_____

*Company*_____

*City*_____ *State*_____

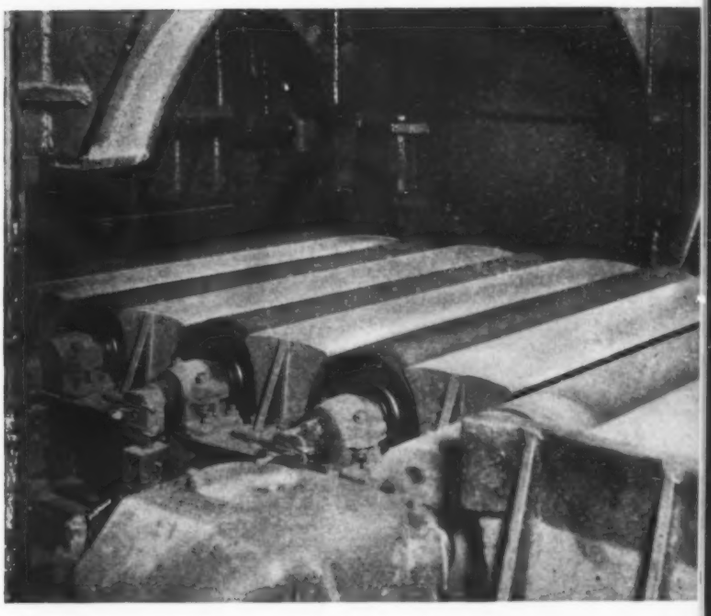
Branch Offices in 25 Principal Cities

Schloemann Installations in a plate mill at Pittsburgh

Left—"Motor-Roller" equipped Scale Table

Below—
"Motor-Roller" equipped Shear Depressing Table

EXCLUSIVE ADVANTAGES *of* SCHLOEMANN "MOTOR-ROLLERS"



With the rotating trunnion-type roller housing the driving motor, the necessity for using line shafts, couplings and gear reduction units is eliminated. Simplified table construction is the result, affording free access along both sides of "Motor-Roller" Tables.

Installation of rollers between the housings of Mill Stands and Shear Housings is possible without introducing complicated or weak elements.

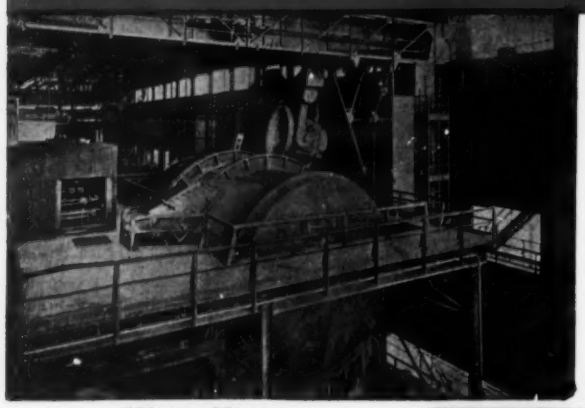
Fewer wearing parts provide the ruggedness and dependability essential in mill service with reduced operating and maintenance costs.

Each "Motor-Roller" installation is designed and built for the particular requirements of its application.

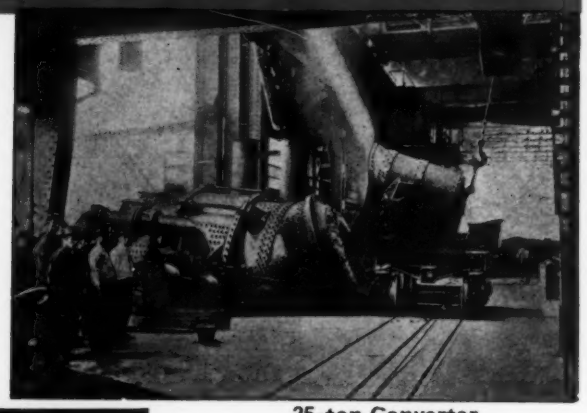
SCHLOEMANN

ENGINEERING CORP. PITTSBURGH, PA.
Rolling Mill Machinery Hydraulic Presses

CONVERTERS, MIXERS
TILTING OPEN HEARTH FURNACES
DUPLEX STEEL PLANTS



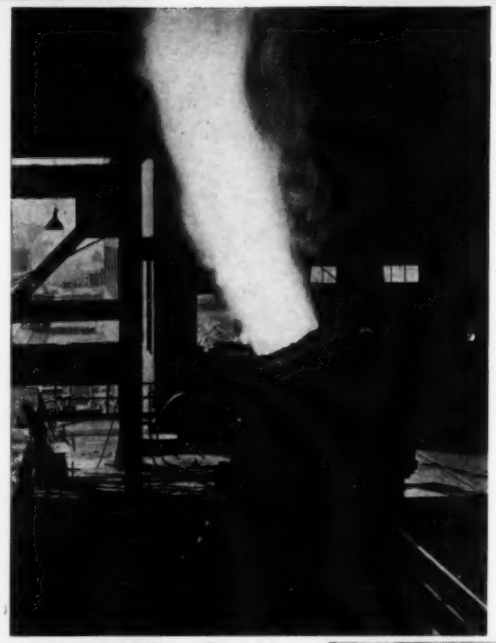
600-ton Mixer



25-ton Converter

These pictures give but small evidence of Pennsylvania Engineering Works' contribution to the Steel Industry.

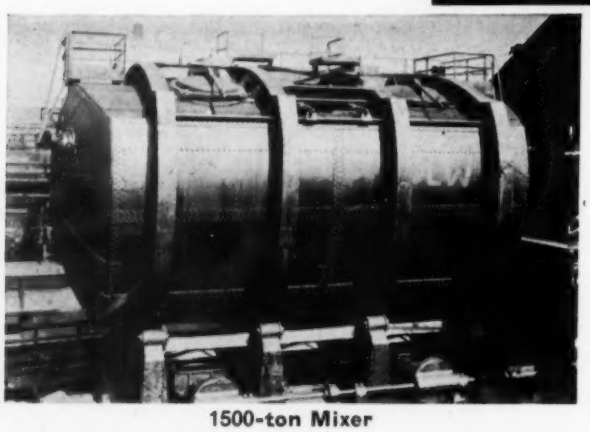
Backed by many years of experience and the great number of installations in the many Steel Plants, the Pennsylvania Engineering Works is prepared to design, fabricate and erect complete Duplex Plants, including Mixers —25 tons to 2000 tons capacity, Open Hearth Furnaces—50 tons to 400 tons capacity—both tilting and stationary, Converters—5 to 50 tons capacity, Converter Jack Cars, Bottom Oven Cars, Regulating Valves, Slag Cars, Ladles, Ladle Cars, Transfer Cars, Jib Cranes and Hauling Systems.



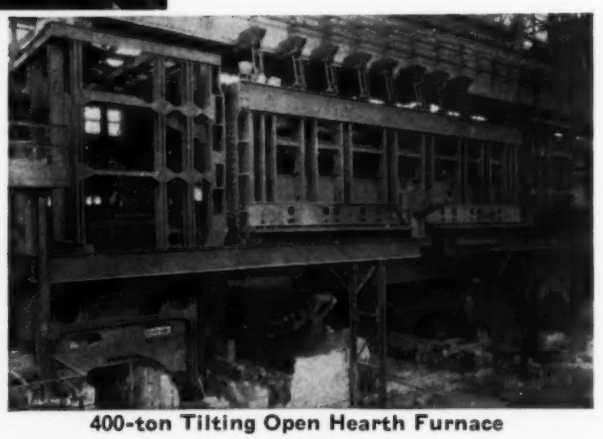
Blowing Charge in 15-ton Converter

Installations of some of the illustrated equipment at

Inland Steel Company
Tennessee Coal, Iron & Railroad Co.
Youngstown Sheet & Tube Company
Illinois Steel Company
Carnegie-Illinois Steel Corporation
Republic Steel Corporation
Bethlehem Steel Company
American Steel & Wire Company
Weirton Steel Company
Jones & Laughlin Steel Corporation
Ford Motor Company, River Rouge
Ford Motor Company, England
Broken Hill Proprietary Co., Australia
Tata Iron & Steel Company, India
Algoma Steel Company, Canada
Steel Company of Canada, Ltd.
Compania Siderurgica del Mediterraneo, Spain
Cia. Fundidora de Fierro y Acero, Mexico



1500-ton Mixer



400-ton Tilting Open Hearth Furnace

Pennsylvania Engineering Works
New Castle, Penna.

GATKE BEARINGS Have Earned These Victory Medals

GATKE Moulded Fabric (Non-Metallic) Bearings incorporate many special features developed by GATKE.

They are engineered for the application and made of different material combinations to meet service requirements, a procedure made possible only by GATKE'S specialized experience and comprehensive manufacturing facilities.

GATKE Bearings are made in three types (1) for water lubrication, (2) for grease or oil lubrication, and (3) for some self-lubricated applications.

The *immeasurable economies* effected by GATKE Bearings on Roll Necks, Spindle Carriers, Universal Couplings and Cranes *indicate the answer* to present day bearing problems.

These *super bearings* have replaced conventional bearings with *wonderful results on the widest range of tough service.* They save critical metals and *do the job far better* . . . last *many times* longer . . . *reduce* maintenance time and expense . . . *save* power and grease.

Changing from metal bearings to GATKE Bearings is simple. Our Engineers have it down to a "T". We can usually furnish GATKE Bearings *moulded to fit present receptacles for replacing metal bearings without machining.*

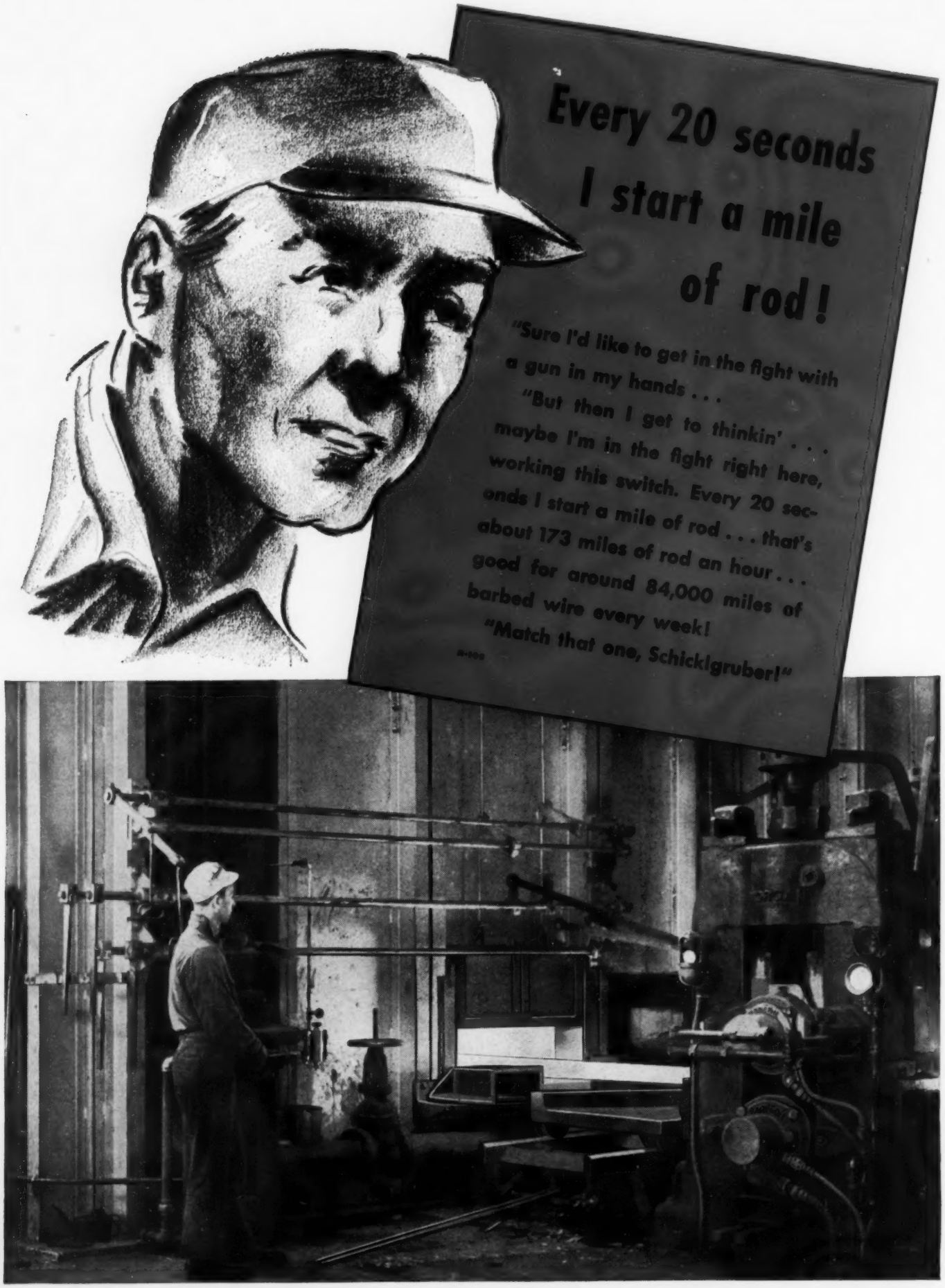
Our extensive experience is *at your service. Just send dimensional print* of bearing and holder with data on load, running speed, lubrication, etc. for recommendations.

Other **GATKE PRODUCTS**
Brake Lining
Clutch Facings
Friction Blocks
Silent Gears
Pump Valves
Piston Rings
Sheet Packings

GATKE CORPORATION • 228 N. LaSalle St., CHICAGO

NON-METALLIC MOULDED FABRIC **Gatke Bearings**

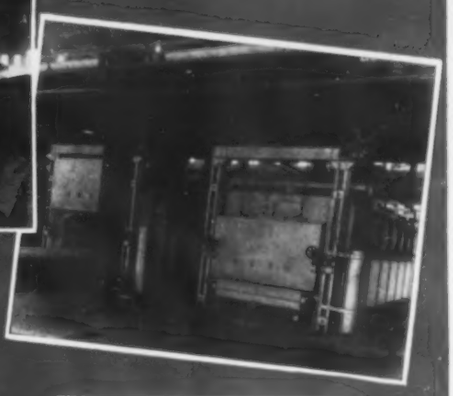
For Roll Necks, Universal Couplings, Spindle Carriers, Table Rolls, Cranes, Acid Resisting Service, and Other Tough Jobs.


Every 20 seconds I start a mile of rod!
"Sure I'd like to get in the fight with a gun in my hands . . .
"But then I get to thinkin' . . . maybe I'm in the fight right here, working this switch. Every 20 seconds I start a mile of rod . . . that's about 173 miles of rod an hour . . . good for around 84,000 miles of barbed wire every week!
"Match that one, Schicklgruber!"

MORGAN CONSTRUCTION COMPANY • WORCESTER, MASS.

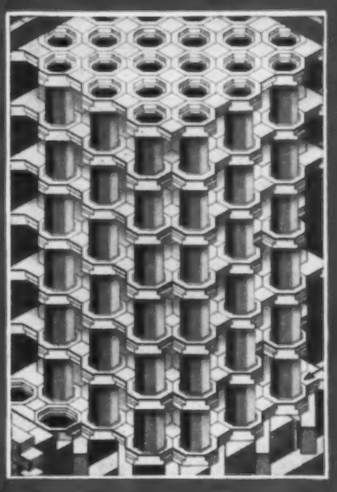
AMCO Equipment for WAR INDUSTRIES

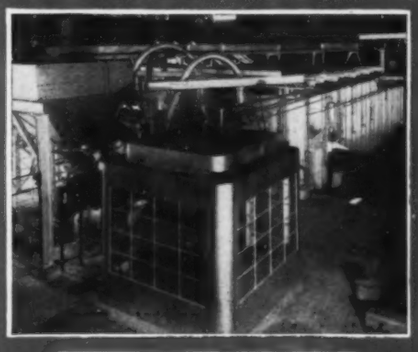
Amco is the largest builder of Modern Pits in the world



Cold-End-Fired Continuous Slab Heating Furnace

Car-Type Annealing Furnace for Castings, Gun Forgings, etc.





Pulverized Coal Equipment and Pulverized-Coal-Fired Furnaces

Furnaces of all sizes for Light Weight and Heavy Forgings

Amco Recuperators — the outstanding recuperators in the field. Over 1100 installations for high temperature furnaces.

Circular Pit Type Heat Treating Furnace for Ingot and Gun Forgings

Rotary Hearth Furnace for Heating Blanks for 155 m.m. Shells

Heavy Duty Forge Furnaces

The AMSLER-MORTON Company

FULTON BUILDING · PITTSBURGH, PA.

ELECTROLYTIC

The Clark Controller Company has had the distinction of being chosen to supply the Electrical Control apparatus on a total of 28 Continuous Processing lines for the Electrolytic Tin Plate Industry.

Bulletin 101 Type
R. D. Mill Master Switch

13 CONTINUOUS TINNING LINES

2 of these—Continuous Electrolytic Tin Plating Lines—have been in successful operation for approximately five years—the other eleven are under construction at the present time.

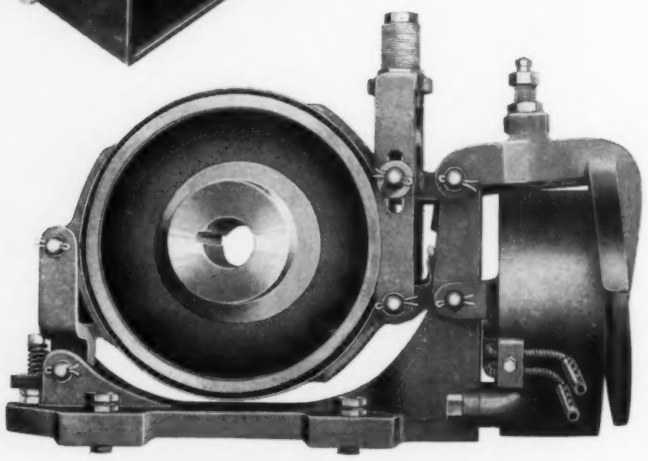
AUXILIARIES TO CONTINUOUS LINES

Pictured on these pages are several types of "3C" apparatus, each designed to deliver maximum service with minimum maintenance.

A "3C" Application Engineer is as near as your telephone.

TYPICAL "3C" BENCH BOARD

"3C"
BULLETIN 102
CAM LIMIT
SWITCH



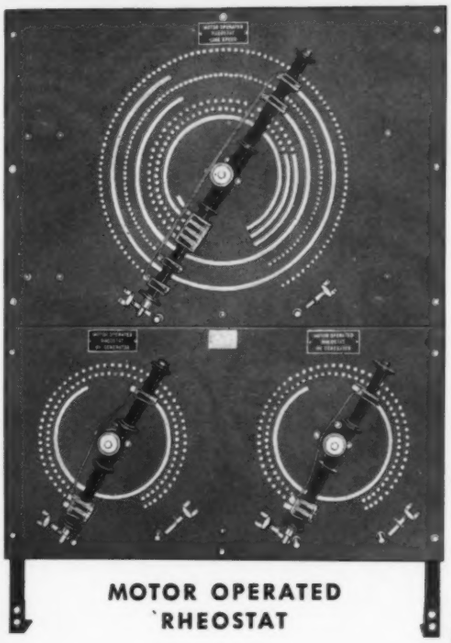
BULLETIN 107 D. C. BRAKE

CONTINUE TO ROLL WITH CLARK CONTROL

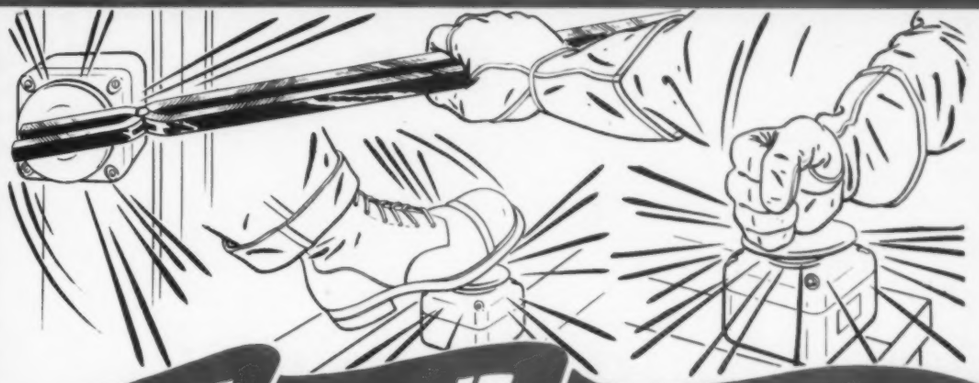
THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

TIN PLATING



MOTOR OPERATED
RHEOSTAT



HIT IT KICK IT PUNCH IT

The Real
"Roughneck"
of the "3C"
Push Button Family

It still does the work

The ROUGHNECK is low and squatty — built close to the ground — and with plenty of "bearing area" so that rough and ready usage doesn't rock him on his base. If you miss that smoothly, flatly curved disc with blows, kicks, or punches, the impact slides smoothly off the shoulders.

These units feature silver-to-silver, button type Double Break Contacts, large electrical clearances, Bakelite insulating parts, push button stop independent of contacts, and all parts removable and replaceable with a screwdriver.

For installations where hard service is encountered, the ROUGHNECK will be entirely satisfactory.

9 SIDE TRIMMING LINES

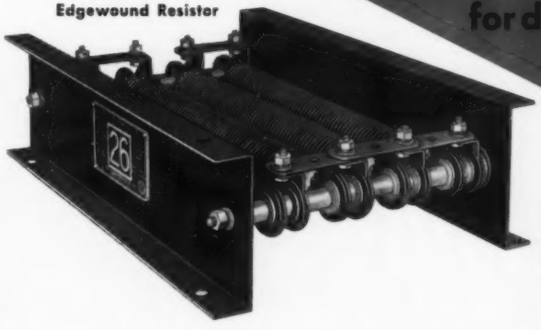
Control for 9 Side Trimming Lines is being manufactured by this company.

6 BRIGHTENING LINES

6 Brightening Lines as well will be equipped with Clark Control.

The Steel Industry is entitled to the highest praise for developing these electrolytic processes. As cooperators with The Reliance Electric & Engineering Co., The Clark Controller Company is proud to contribute its engineering experience and effort to such a vital factor in the Tin Conservation program.

Bulletin 110
Edgewound Resistor



Welded End Terminal
on Edgewound Resistor

CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

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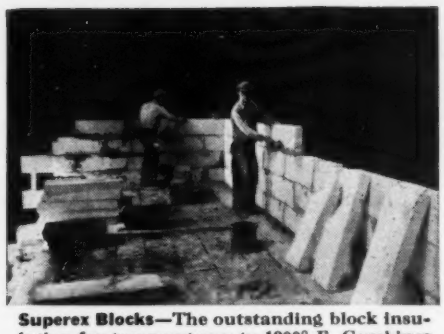
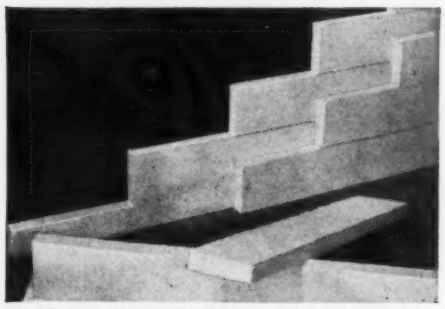
For greater efficiency and maximum fuel savings in iron and steel industry service...

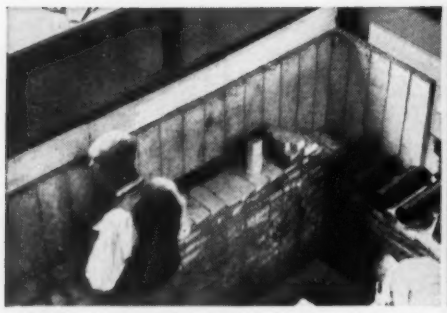
Johns-Manville Insulations



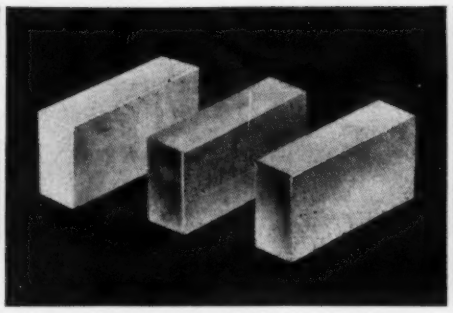
Superex Blocks—The outstanding block insulation for temperatures to 1900° F. Combines high heat resistance with low thermal conductivity. Standard sizes 3″ x 18″, 6″ x 36″ and 12″ x 36″; from 1″ to 4″ thick.



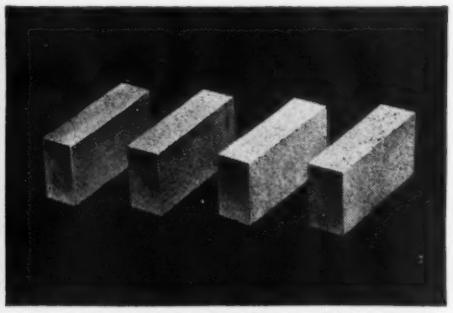
J-M 85% Magnesia Blocks—For many years the most widely used block insulation for temperatures to 600° F. Highly efficient and durable. Standard sizes 3″ x 18″, 6″ x 36″ and 12″ x 36″; from 1″ to 4″ thick.



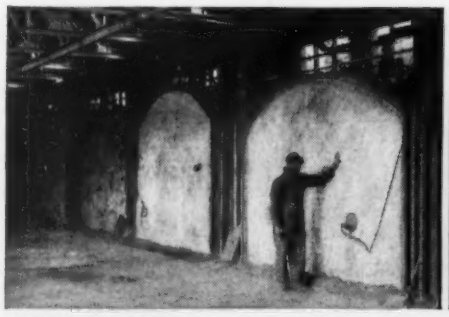
J-M Superex Combination—An inner layer of Superex and an outer layer of J-M 85% Magnesia. Combines high heat resistance and exceptional insulating efficiency. Available in both block and pipe-covering forms.



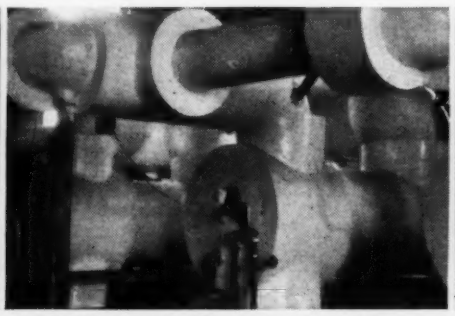
3 Types of Insulating Brick . . . Sil-O-Cel Natural Brick (1600° F.); Sil-O-Cel C-22 Brick (2000° F.); Sil-O-Cel Super Brick (2500° F.). Available in all standard 9″ shapes of the 2½″ and 3″ series.



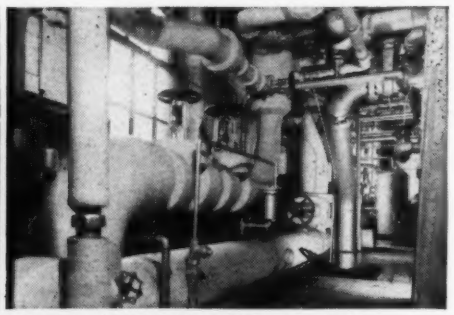
4 Types of Insulating Fire Brick—JM-16 (1600° F.); JM-20 (2000° F.); JM-23 (2300° F.); JM-26 (2600° F.). Combine light weight, low conductivity, low cost. All standard 9″ shapes of the 2½″ and 3″ series.



Sil-O-Cel C-3 Concrete—Cast on the job from Sil-O-Cel C-3 aggregate and cement. Sets up into a durable semi-refractory insulating concrete for use up to 1800° F. 28 lbs. required per cu. ft. Shipped in 100-lb. bags.



J-M 85% Magnesia Pipe Covering—Long recognized as the standard pipe insulation for temperatures up to 600° F. Highly efficient, durable, long lasting. Furnished in 3-ft. lengths in thicknesses up to 3″.



Asbesto-Sponge Felted Pipe Insulation—Especially suited to steel mill service because of its unusual durability and resistance to abuse. For temperatures to 700° F. Furnished in 3-ft. lengths in thicknesses up to 3″.

JM PRODUCTS

For details on these materials, and on the complete J-M Insulation line, write for catalog GI-6A. Johns-Manville, 22 East 40th Street, New York, N. Y.

Johns-Manville INDUSTRIAL INSULATIONS

For every temperature . . . for every service

YOU CAN COUNT ON WAGNER

...for Dependable Transformer Performance

WAGNER POWER TRANSFORMER

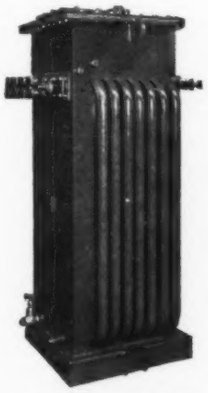
BUY U.S. WAR BONDS

In the steel industry, where production must be maintained at an all-time high to supply the enormous quantity of steel necessary to produce war equipment, dependable electric power is of major importance.

The transformers are the vital links in any electric power distribution system. If the transformers fail, unsatisfactory service results – production is delayed and operating costs go up.

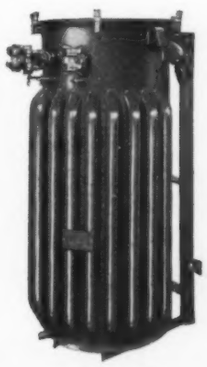
Wagner Transformers have established outstanding records in the steel industry for continuous service and long life. Carefully controlled production methods, highest quality materials, rigid inspection and tests, plus 50 years of transformer engineering experience, are just a few of the reasons why you can count on Wagner for dependable transformer performance.

Wagner can take care of all of your transformer requirements. 25 branch offices, located in as many principal cities and manned by trained field engineers, are always ready to help you.



WAGNER NOFLAMOL TRANSFORMER

WAGNER AIR-COOLED TRANSFORMER



WAGNER HEX TRANSFORMER

T42-11

Wagner Transformer Features:

Liberal insulation—extra end turn insulation provides added protection against line surges and voltage disturbances . . . Heavy tank construction—heavy steel plate, electrically welded, sand-blasted and flow-painted . . . Core iron of non-aging silicon steel—has high magnetic permeability and has very low hysteresis and eddy-current losses . . . Tap changer contacts of low resistance and with high over-current capacity, securely held in place and accurately aligned . . . Bushings—wet-processed porcelain, either solid or oil-filled, with ample mechanical and electrical strength to withstand stresses encountered in service . . . Transformer Oil—has high dielectric strength, proper viscosity, safe flash-point, and resistance to sludging.

Complete Information sent on Request

Wagner Electric Corporation

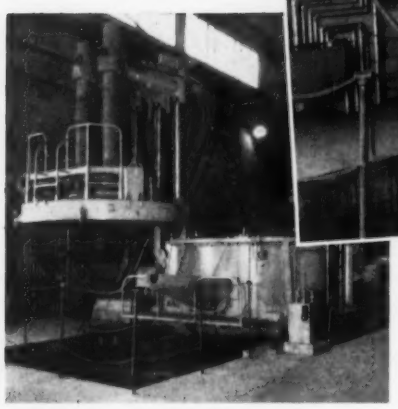
6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

TRANSFORMERS • MOTORS • FANS • BRAKES

for RAPID and ECONOMICAL *Steel Production*

1.

TOP
CHARGE
TYPE



2.

3.

MOORE RAPID *Lectromelt* FURNACES

Here is a recent installation of a 10 ton capacity LECTROMELT, top charge type furnace, shown:

1. in normal operating position
2. with roof raised and rotated, ready for charging
3. in pouring position.

★ This is the second LECTROMELT FURNACE installed in the same plant and a third is now being constructed. These and many other LECTROMELTS are producing essential alloy steels 24 hours per day, seven days a week.

Top charge type LECTROMELTS produce more steel in less time and with a lower consumption of power. There are additional savings from lower electrode and refractory costs. Top charge type LECTROMELTS are built in standard sizes ranging from 100 tons down to 250 pounds capacity. Detailed information will gladly be furnished on request.

PITTSBURGH LECTROMELT FURNACE CORPORATION
PITTSBURGH, PENNSYLVANIA

CHECK THE FACTS on R&IE Products

ENGINEERING AN
PRODUCTION

COMPLETE
SUBSTATION

OPERATING
MECHANISMS

DISCONNECTING
SWITCHES

AIR BREAK SWITCH

CONNECTORS

BUS CLAMPS

CUTOUTS

THERMO-RUPTER

METAL HOUSED
ISOLATED BU

AUTOMATIC
THROW-OVER
EQUIPMENT

METAL CUBICL

INTERLOCK

TESTING DEVIC

1 Cylindrical, isolated phase bus, individually housed to prevent interphase short circuits.

2 Mounting frames take all stresses. Bus easily mounted on wall, floor, or ceiling or other structures. Housings are enclosures only.

3 Insulators are used only in compression. All insulators are interchangeable.

4 Conductors supported by sleeve can be either anchored for fixed position or allowed to slide for expansion position. Conductors can be square, round, channel or bar, bare or insulated.

Enclosed ISOLATED PHASE *Bus*

An original R&IE development. This new type of bus is suitable for any voltage and current. It offers greater safety, flexibility, ease of installation and inspection, than any other type of bus arrangement. Conductors may be installed, aligned, adjusted and inspected before covers are attached. Inspection is possible at any time, at any location, by removing a few bolts and cover.

RAILWAY AND INDUSTRIAL ENGINEERING CO. • GREENSBU

In Canada—Eastern Power Devices Ltd., Toronto

GET YOUR ANSWER AT
America's War Conference on Metals!

War has developed new products, new production equipment and new ideas. All of these aids to greater production will be shared when the metal industry meets for the 24th year at the National Metal Congress and a War Production Edition of the National Metal Exposition, the week of October 12, in Cleveland.

Here is your opportunity to discuss your problems with other leaders in the industry. It is your opportunity to see what war metals are adaptable to your production, to study the best in equipment and supplies, to learn how other plants are meeting their war problems.

This is your opportunity—and your responsibility—to help your industry carry forward its giant task of winning this war of metals. You may listen to as many as 100 technical papers presented by the four great cooperating societies. You may attend the numerous war production conferences. You may consult with manufacturers' experts in more than 230 educational displays. Plan to attend this great war conference on metals.

● *Display Space Still Available—more than 230 manufacturers have reserved 89% of the display space available in this 100% educational meeting. If you serve the metal industry, reserve your space now and put your technical experience and information on the war production line, where it will do the most good today.*

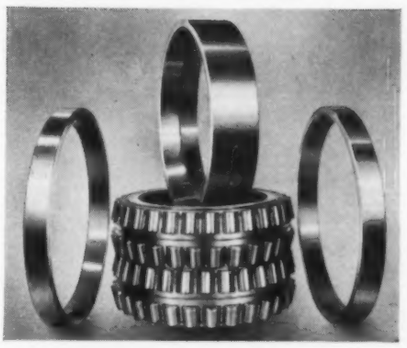
TIME
OCTOBER 12 TO 16,
MONDAY THRU FRIDAY

PLACE
CLEVELAND'S
PUBLIC AUDITORIUM

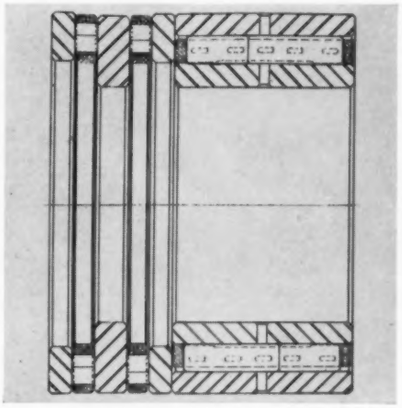
EVENT
THE NATIONAL METAL
CONGRESS AND
WAR PRODUCTION EDITION
NATIONAL METAL
EXPOSITION

THEME
INCREASED PRODUCTION
OF WAR PRODUCTS

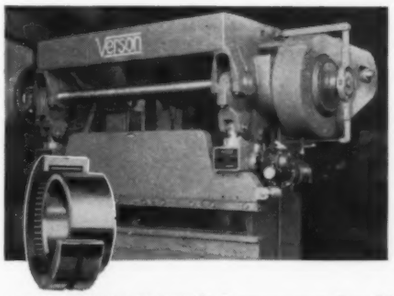
STEEL MILL NEWS
OF BANTAM BEARINGS



4-ROW TAPERED ROLLER BEARINGS, manufactured by Bantam in sizes up to 51" O.D., are especially suitable for such applications as back-up rolls and roll necks on hot and cold strip mills. Bantam Straight Radial Roller Bearings are also extensively used in this type of application.

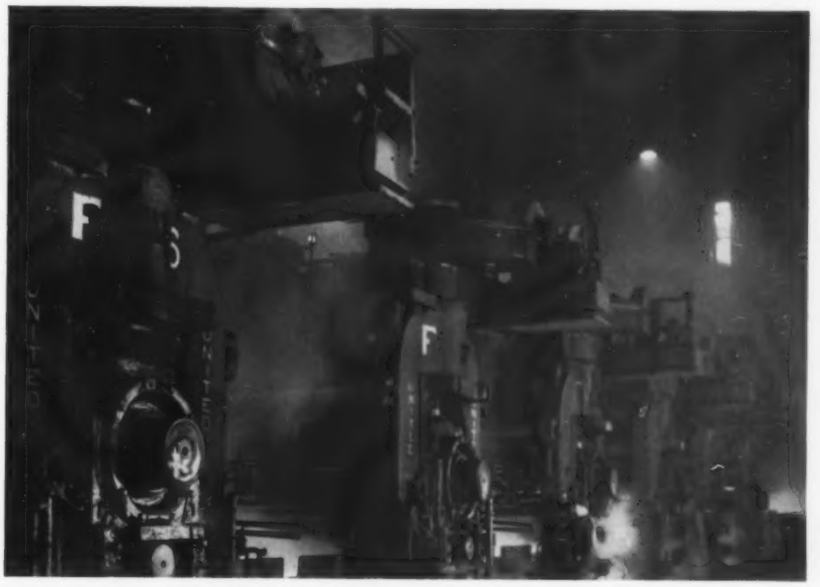


BANTAM-DESIGNED MILL TYPE BEARINGS combine a radial roller section with a double-direction thrust bearing. Used at one end of roll necks, these bearings provide necessary thrust capacity, permit use of Straight Radial Roller Bearings at opposite end. Bearings of this type are made in three lengths for each bore size, providing a wide capacity range.



METAL FORMING PLANTS find many uses for this 45-ton press brake, built by Verson All-Steel Press Company for such applications as straightening armor plate, forming aircraft parts, and producing munitions boxes and other equipment. High-speed flywheel shafts of these machines rotate on Bantam Quill Bearings.

EVERY MAJOR TYPE of anti-friction bearing is included in Bantam's line—straight roller, tapered roller, needle, and ball. With this broad background of experience, Bantam's engineers are well qualified to cooperate in the selection of standard bearings, or design special ones, for every steel mill application. If you have a bearing problem of any kind, TURN TO BANTAM.



BANTAM SERVES THE STEEL INDUSTRY with a wide range of sizes and types of anti-friction bearings engineered for severe service requirements. Typical application of Bantam Bearings is on work rolls and back-up rolls of this continuous hot strip mill in one of the country's major steel plants.

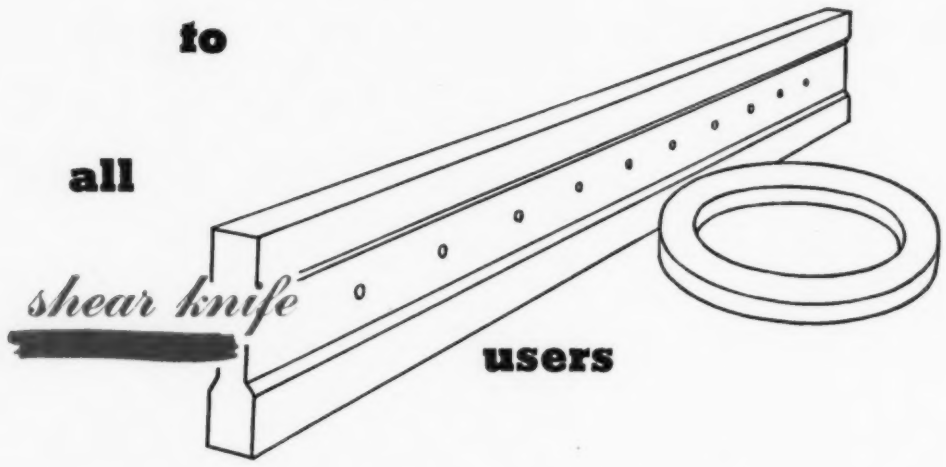
ULTRA-PRECISION IN LARGE BEARINGS made by Bantam is assured by special machining and grinding methods that result in extremely low tolerances, both in dimensions and in concentricity. Hardening techniques developed by Bantam engineers produce unusual toughness and strength, and contribute to successful bearing performance.

BANTAM BEARINGS
STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

BANTAM BEARINGS CORPORATION • SOUTH BEND • INDIANA

An *Important* message

to all *shear knife* users



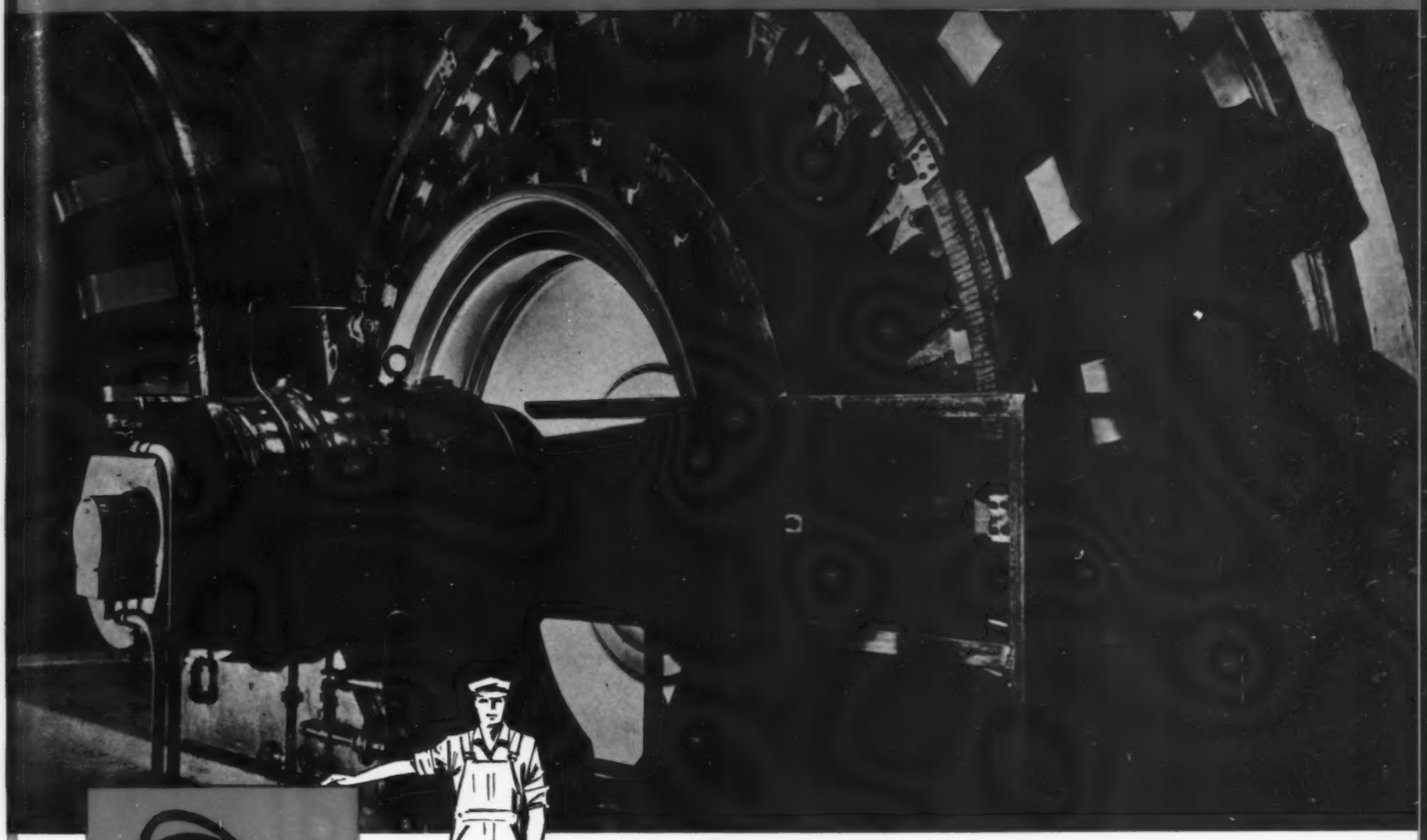
Due to greatly expanded production facilities, Heppenstall carbon or alloy steel shear knives are currently available for prompt delivery upon receipt of your order. There has been no change in Heppenstall quality standards . . . knives are still made of special analysis steel in Heppenstall's own electric induction furnaces.

If War Work has given you new shearing problems, please call upon Heppenstall engineers to add their experience to yours to help speed your production. Write now—general offices 4620 Hatfield St., Pittsburgh, Pa., or phone MAyflower 2000.

World's Oldest and Largest Producers of Solid Steel Shear Knives

Heppenstall Company

- so that steel mill production is on our side!



The three brushes above are typical MORGANITE types especially designed for steel mill applications.

MORGANITE BRUSHES PERFORM DEPENDABLY . . . CONTINUOUSLY

With steel mill operation running consistently at 98% of capacity this year, it is not surprising that the task being fulfilled is a cause of wonderment. Tanks, ships, planes, trucks, shells, guns—each a separate phase of war production—require tremendous tonnage.

To make sure that the "balance of steel" is favorable to the United Nations, a tremendous responsibility rests on the shoulders of plant engineers and superintendents. These individuals, in turn, must rely on their equipment for day and night production.

It is here that MORGANITE brushes are a vital part of the steel mill functioning, in both main and auxiliary drives.

Their ability to withstand sudden current surges, stand up under heavy loads, maintain good commutation, and ride quietly at high speeds, is accountable in part for the extensive use of MORGANITE brushes in the steel industry.

MORGANITE engineers are available for collaboration on brush problems. Your inquiries are invited, without obligation of course.

MORGANITE BRUSH CO., INC.

TRADE MARK

LONG ISLAND CITY, NEW YORK

BEARINGS GOBBLED GREASE

LIKE HUNGRY WOLVES

until this plant switched to Tycol Green Cast Greases

Lubricating a soap-cooling machine consisting of two large steam heated drums and two water-cooled rolls was a continuous problem to this plant. Steam passing through the roll hubs at 300°F made bearings so hot that grease quickly thinned down and dripped away. Even though grease boxes were filled every day, bearings were constantly burning out. Then a Tide Water engineer recommended switching to Tycol Green Cast Grease. Since making the change this plant has ended former lubrication worries, and cut down extravagant grease consumption.

"Our practice now", says the plant superintendent, "is to put about five pounds of grease into each box and almost forget about them for two weeks or longer. Tycol is undoubtedly the right grease for the job. It stands the high temperatures and does a thorough job of lubricating. The amount of grease we save, the repair bills we avoid, and the hours of labor we do away with make this decidedly an example of how waste can be eliminated by using the correct grease." Tycol Green Cast Greases are made with fine quality cylinder oils and a minimum of soap. More cylinder oil—less soap means better lubrication under all operating conditions.

Let a Tide Water engineer show you how to step up production through efficient lubrication. Write the Tide Water Associated Oil Company, 17 Battery Place, New York, N. Y.

DRUMS, DRUMS, DRUMS

War needs make it extremely important that all empty drums be returned immediately.

Principal Branch Offices: Boston, Philadelphia, Pittsburgh, Charlotte, N. C.

TIDE WATER ASSOCIATED OIL COMPANY

EASTERN DIVISION: 17 Battery Place, New York, N. Y.

MAKERS OF THE FAMOUS VEEDOL MOTOR OIL

INDUSTRIAL TYCOL OILS-GREASES

TIDE WATER INDUSTRIAL LUBRICANTS

THERE IS A COMPLETE LINE OF TYCOL LUBRICANTS SCIENTIFICALLY ENGINEERED FOR EVERY INDUSTRIAL USE

IT IS POSSIBLE...

that one of the reasons why we at R. D. WOOD

are so busy is that we have been known for years as builders of *good* hydraulic presses

and equipment. At any rate, we have long been working night and day

in producing as many presses as possible...without deviating from our normal high standards of sound design

and careful workmanship.

Even though we might not be able to fill your hydraulic press requirements on short notice, our engineers will be glad to cooperate,

to the limits of their available time, in helping you solve your press

problems.

★

BENDING PRESSES • CRIMPING PRESSES • DEHYDRATING PRESSES • DIE SINKING PRESSES • DOUBLE ACTING PRESSES • DRAWING PRESSES • FORCING PRESSES—VERTICAL AND HORIZONTAL • FORGING PRESSES • FORMING PRESSES • JOGGLING PRESSES • LABORATORY PRESSES • LAMINATING PRESSES • PLATE FLANGING PRESSES • SCARFING PRESSES • SECTIONAL FLANGING PRESSES • PRESSES FOR FORGING, DRAWING, PIERCING AND TESTING OF SHELLS • STRAIGHTENING PRESSES • UPSETTING PRESSES • SPECIAL PRESSES

HYDRAULIC PRESSES FOR EVERY PURPOSE

R. D. WOOD CO.

PHILADELPHIA • PENNSYLVANIA

Providing-

TOP SPEED AND STAMINA *RIGHT NOW*

-with **FLEXIBLE ADAPTABILITY** *for* **FUTURE NEEDS!**

• Now, when demand is ever upward, Vaughn Wire Drawing Machinery give you the *speed, strength, safety* that take the full measure of your war production without fail.

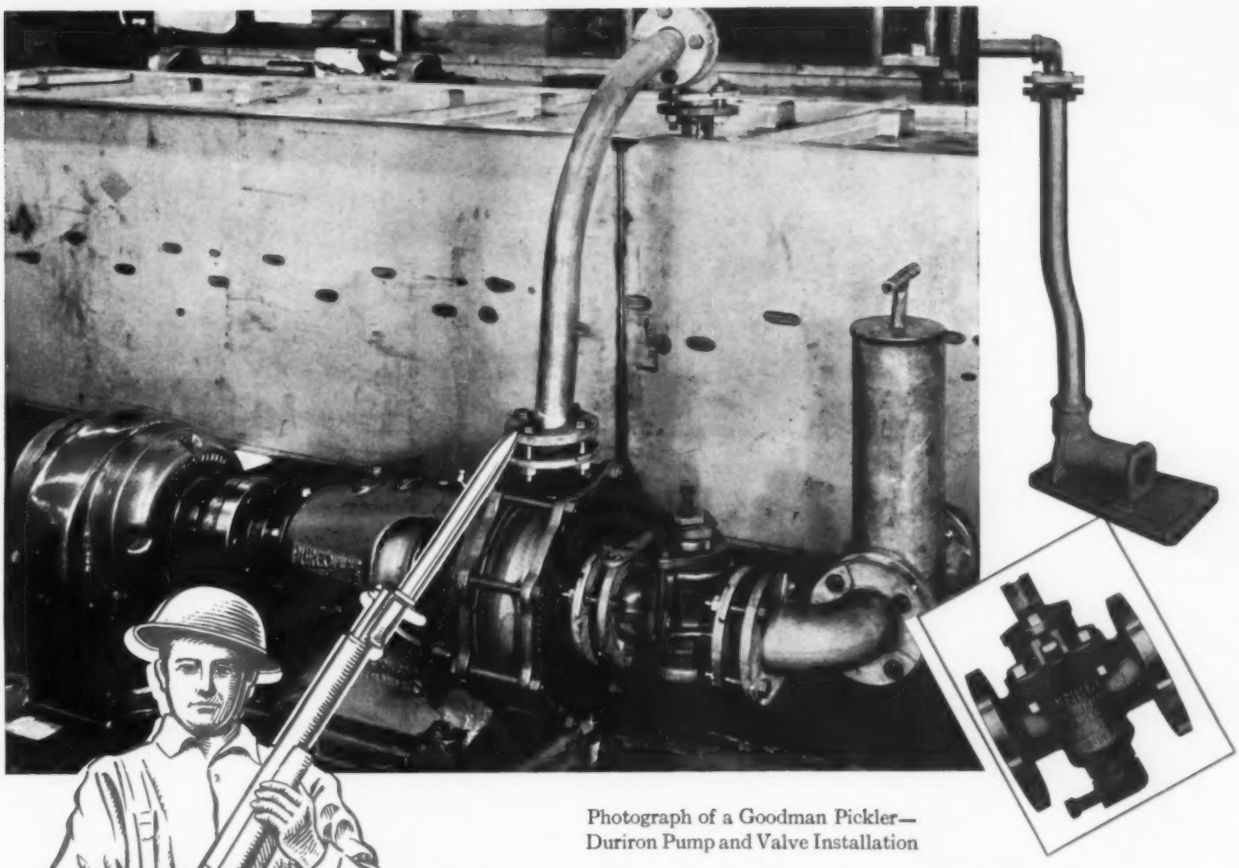
In the coming years, when markets are competitive and new wire products come thick and fast, you'll enjoy the built-in *adaptability* of these same machines—and profit by Vaughn's far-sighted engineering.

VAUGHN

WIRE DRAWING MACHINERY

COMPLETE COLD DRAWING EQUIPMENT
Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire...Ferrous, Non-Ferrous Materials or their Alloys.

THE VAUGHN MACHINERY CO.
CUYAHOGA FALLS, OHIO, U. S. A.



Photograph of a Goodman Pickler—
Duriron Pump and Valve Installation

GOODMAN PROTECTS THEIR CUSTOMERS

from corrosion troubles by using Duriron Company equipment in their Continuous Cleaning Machines.

Each Goodman unit is equipped with —

1 — Two Duriron 4 in. suction, 3 in. discharge Model 40 centrifugal pumps for circulating the pickling solution. Also Duriron plug cocks and fittings in connecting lines.

2 — Durimet* Type 604 Lubricated Plug Valves for the bottom outlet of each tank.

3 — All Duriron pumps, valves and fittings equipped with Durimet* flanges.

4 — A Duriron steam jet for heating in the hot water rinse tank.

**Durimet is the Duriron Company's high strength alloy steel so widely used for hot sulphuric acid of pickling strength, both with or without the addition of hydrofluoric acid.*

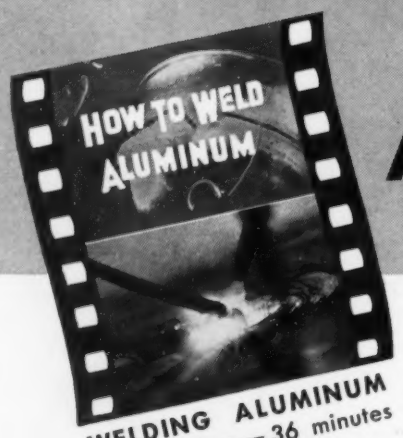
A good pickling system is vitally important these days. The Goodman units supplied with Durco acid-handling equipment are built to give you speed, efficiency and long life under the toughest corrosive conditions.

DURIRON · DURICHLOR
CORROSION-RESISTING
DURCO
ALLOYS & EQUIPMENT
THE DURIRON CO. INC.
DAYTON, OHIO
DURIMET · DURCO STAINLESS STEELS

THE DURIRON COMPANY, INC. DAYTON, OHIO, U.S.A.

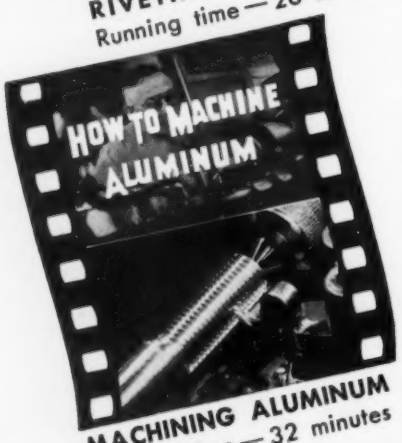
3 NEW FILMS

FOR TRAINING ALUMINUM WORKERS



WELDING ALUMINUM
Running time — 36 minutes

RIVETING ALUMINUM
Running time — 26 minutes



MACHINING ALUMINUM
Running time — 32 minutes

Valuable "how-to-do-it" data on Welding, Riveting and Machining Aluminum is contained in these three, brand-new sound motion pictures. Designed to supplement texts and teaching, these films are offered for your assistance in training war workers in the fabrication and assembly of Aluminum Alloy parts and structures.

No drama, no humor, no romance! Every foot of these films is packed with hard-hitting task instruction.

"How To Weld Aluminum" describes and demonstrates the various essentials of torch and arc welding, brazing and resistance welding. "How To Rivet Aluminum" portrays the making and testing of rivets, preparation of the work, actual rivet-driving techniques and inspection. "How To Machine Aluminum" discusses alloys usually used, the kind and shapes of tools, cutting compounds, speeds and feeds.

Task instruction is made easier.

35 mm. and 16 mm. SOUND PRINTS AVAILABLE FOR LOAN OR PURCHASE

Prints of these black and white, sound motion pictures are loaned free.

List the titles of the pictures you want . . . your first and second choice of dates when you want them . . . whether you want 35 mm. or 16 mm. prints . . . and the approximate number of days you expect to use them. (NOTE: These films can be shown *only on sound projectors.*)

If you want to purchase prints for your permanent library, they are available at cost, shipping charges prepaid. Prices follow.

	16 mm. with fibre container	35 mm. with metal container
How To Rivet Aluminum	1200-ft. reel . . $42.80	2000-ft. reels . . $103.80
How To Weld Aluminum	1600-ft. reel . . 62.70	2000-ft. reels . . 176.30
How To Machine Aluminum	1200-ft. reel . . 50.70	2000-ft. reels . . 123.55

Send your requests for loan or purchase to Aluminum Company of America, 2128 Gulf Building, Pittsburgh, Pennsylvania.

See these films at the National Metal Exposition, Cleveland, October 12-16.

ALCOA ALUMINUM

MAKE SURE YOUR PLANT IS AWAKE at the SWITCH!

THESE three types of Trumbull Heavy Duty Industrial Switches are built to stand the grind of three-shift industrial service and for use as motor circuit disconnects. All three perform the same heavy duty functions but differ in design to meet engineering preferences.

STYLE "A"... Features ALL parts OBSERVABLE and REMOVABLE from the front.

STYLE "RBA"... Equipped with FRONT-SIDE handle, permitting close ganging. Receding contacts quench arc in special chamber. Entire switch mechanism mounted on removable saddle.

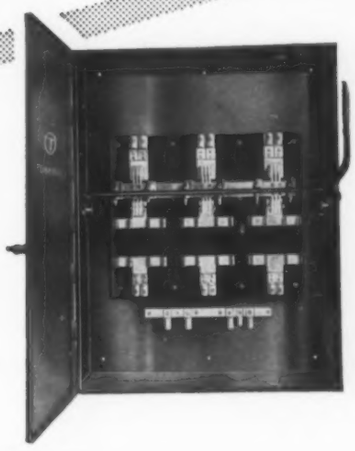
TYPE "C"... Designed for use where there is less frequent operation and less likelihood of continuous heavy load.

All are quick-make, quick-break, with horsepower rating. All except Type "C" have interlocking covers.

Further illustrated and described in Trumbullaid Bulletin 402.

STYLE "A"

30 to 2400 Amps., 230-575 V. AC; 250-600 V. DC, 2, 3, 4 pole, single throw, fusible and no fuse. Double throw, 30 to 600 amp. capacities. H.P. ratings 30 to 400 amp.



STYLE "RBA"

30 to 600 amps., 230-575 V. AC; 250-600 V. DC, 2, 3, 4 pole, single throw, fusible and no fuse. H. P. ratings same as Style "A."

TYPE "C"

30 to 600 amps., 230-575 V. AC; 250 V. DC, 2, 3, 4 pole fusible and no fuse, single throw. H. P. ratings same as Style "A."

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY
PLAINVILLE, CONN.

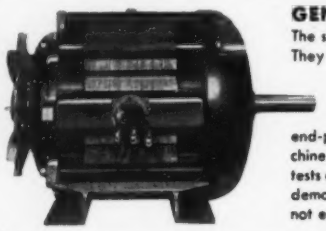
THE TRUMBULL ELEC. MFG. CO. — PLAINVILLE CONN. U.S.A.

OTHER FACTORIES AT NORWOOD (CINN.) O. — SEATTLE — SAN FRANCISCO — LOS ANGELES — TRENTON, N. J. (PORCELAIN)

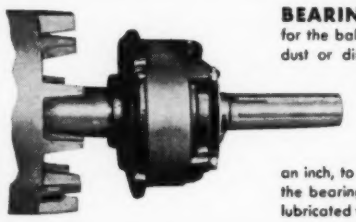
Here's the "INSIDE" Story on

WAGNER CP MOTORS

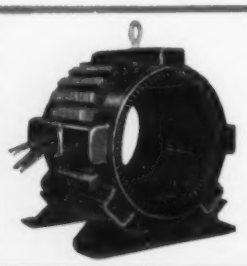
WAGNER type CP totally-enclosed fan-cooled motors have two frames: an outer frame which guides a strong draft of cool air over the motor, and an inner frame which protects the vital parts of the motor against the entrance of metal dust, filings, steel chips, and other destructive agents. Ball bearings are used throughout. Cartridge completely seals the bearings against dust and dirt even when the rotor is removed from the motor. Endplates are machined to accurate dimensions for close frame fit. • • It is because of such features and those illustrated and described below that Wagner CP totally-enclosed, fan-cooled motors have been accorded a wide acceptance by steel mills and metal working plants.



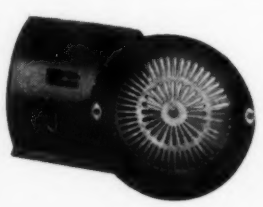
GENERAL CONSTRUCTION. The stators are practically unbreakable. They are constructed entirely of steel, with the component parts welded together to obtain maximum strength with minimum weight. The end-plates are cast iron, accurately machined for perfect stator fit. Laboratory tests and extensive field experience have demonstrated conclusively that dust does not enter Wagner CP motors.



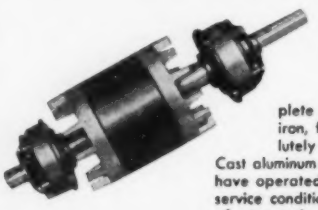
BEARINGS. Full cartridge construction for the ball bearings makes it impossible for dust or dirt to reach them even when the rotor is removed from the motor. The cartridges are heat treated, and then machined to dimensions which are held to tolerances less than a thousandth of an inch, to match the accurate dimensions of the bearings. Wagner CP motors are quickly lubricated without interrupting their operation.



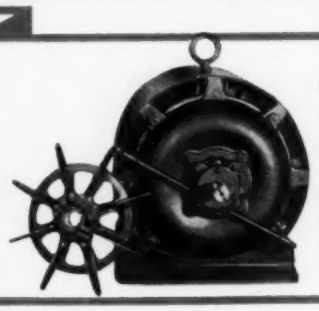
WINDINGS. The windings are insulated with the best materials obtainable, used in generous amounts. The windings are pre-formed to exactly fit the stator slots without crowding. They are effectively insulated from the stator punchings by cuffed slot cells made of tough fibrous material. The exposed parts of the windings are completely taped well into the slots, and the assembled stator windings are treated with high-grade insulating varnish, giving the coils a glossy surface for easy cleaning.



STATOR AND FAN SHIELDS. The stator shield is formed from steel plate and is rigidly bolted to the motor frame. The fan shield is also formed from steel plate with the grating as an integral part of the shield. No wire mesh is used because of its susceptibility to rapid erosion in unfavorable atmospheres, and its lack of rigidity and consequent inability to protect the ventilating fan. Because of close tolerances and snug fit between stator and fan shields, the motor presents a streamlined appearance.



ROTOR. The squirrel-cage is of aluminum, cast under heavy pressure to completely fill the closed rotor slots and the moulds which form the end-rings. The rotor bars and end-rings make complete and intimate contact with the core iron, facilitating heat transfer and absolutely eliminating squirrel-cage vibration. Cast aluminum rotors are not an experiment. They have operated successfully for many years under service conditions which have caused other types of rotors to become brittle and fail in a short time.



VENTILATION. The air ducts of Wagner CP motors are extra large and do not become clogged by dust or dirt. The ventilating fan is of aluminum, does not produce sparks when accidentally hit by metal, and moves a large volume of air at high velocity.

BUY U.S. WAR BONDS

Field Engineering Service . . . PITTSBURGH, NEW YORK, CHICAGO, and all of the rest of Wagner's 25 branches are manned by trained field engineers competent to solve your motor application problems.

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MOTORS • TRANSFORMERS • FANS • BRAKES

WELLMAN *Industrial* FURNACES

An Installation of Wellman side-door Ingot Furnaces. Each furnace has two chambers; normal charge each chamber is 18, 12" x 12" x 50" ingots (often increased 50 to 100%). Operating temperatures up to 2400° F., using oil or washed anthracite producer gas. Served by 2,000 lb. Wellman Ingot Charging and Withdrawing Manipulator.

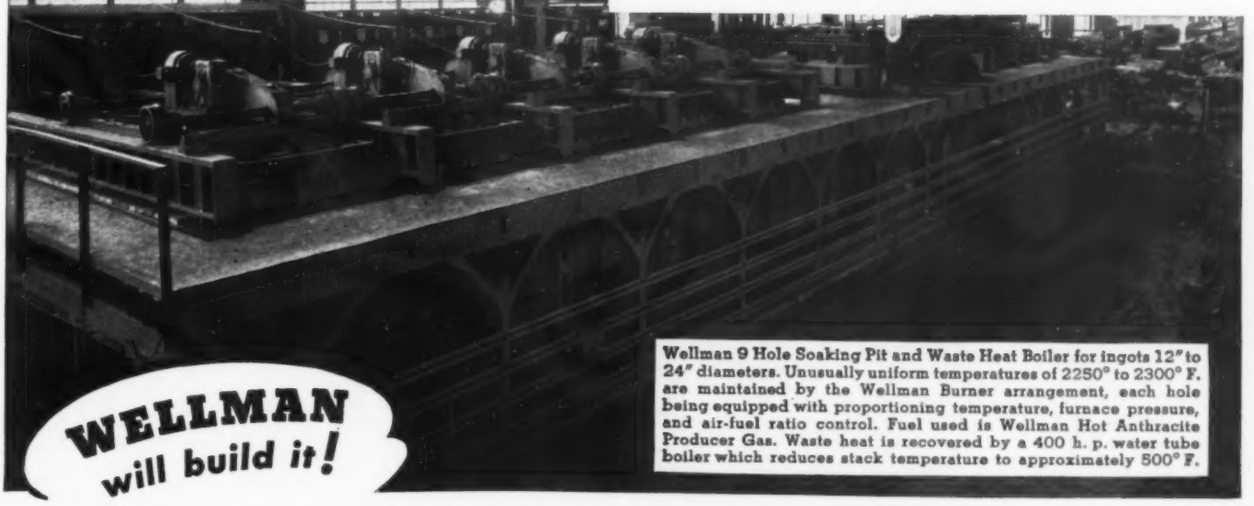
Two Wellman Furnace installations for annealing, normalizing, low temperature annealing, hardening and drawing high carbon steel bars and gun barrels. Furnace dimensions, 22' wide x 20' effective length. Installation includes rotary quenching mechanism, chargers, ejectors, run-out tables, and oxy-acetylene cut-off machine. A Wellman gas plant supplies washed anthracite gas to produce operating temperatures from 900° F. to 1650° F.

for INGOTS, BILLETS, SLABS, BARS, RODS—*and GUN BARRELS!**

Wellman Furnaces represent the last word in design, control, automatic operation, and installation. Our Furnace department is headed by engineers who are thoroughly experienced in the specialized field of heat-treating (continuous and reheating), normalizing, and annealing. We can assume responsibility for the design, manufacture, and erection of complete installation, including gas generating plants, ovens, and furnaces, and material handling equipment.

**If you have a problem of converting your heat treating furnaces from regular service to high speed war production, perhaps we can help you. Write*

THE WELLMAN ENGINEERING COMPANY
7008 Central Avenue • Cleveland, Ohio



Wellman 9 Hole Soaking Pit and Waste Heat Boiler for ingots 12" to 24" diameters. Unusually uniform temperatures of 2250° to 2300° F. are maintained by the Wellman Burner arrangement, each hole being equipped with proportioning temperature, furnace pressure, and air-fuel ratio control. Fuel used is Wellman Hot Anthracite Producer Gas. Waste heat is recovered by a 400 h. p. water tube boiler which reduces stack temperature to approximately 500° F.

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Car Dumpers • Charging Machines • Cranes • Industrial Furnaces • Soaking Pits • Gas Plants • Reversing Valves

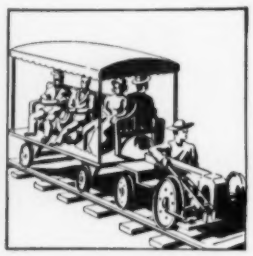
Only active amps can help your plant win a Navy E or an Army A. Amperes wasted through faulty commutation are no more useful than a cripple on the battle line. Good commutation is good co-operation in meeting war-size production schedules.

SPEER can help war-condition your electrical equipment by prescribing exactly the right brush grade for each application. It is remarkable how greatly performance can be improved by such simple treatment. For example, one of the largest plants had a great deal of trouble finding brushes that would give long life with the desirable commutative qualities. SPEER Multiflex E-27 whipped the problem hands down.

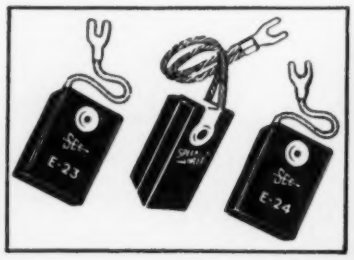
And that is no isolated case. SPEER records are full of them. Your active amp quota can be boosted if you will take these simple steps:

1. Write SPEER for a supply of Brush Data Forms — one for each machine you want to improve.
2. Fill out the forms.
3. Mail them to us.

Famous American Firsts



Edison's electric railway, 1880.



SPEER BRUSHES—To meet the requirements of most industrial motors, SPEER Electro-Graphitic Brush grades E-23 and E-24. Also available as Multiflex Brushes. Write today for complete descriptive catalog.
There is *one right* brush grade for every job—and SPEER makes it.

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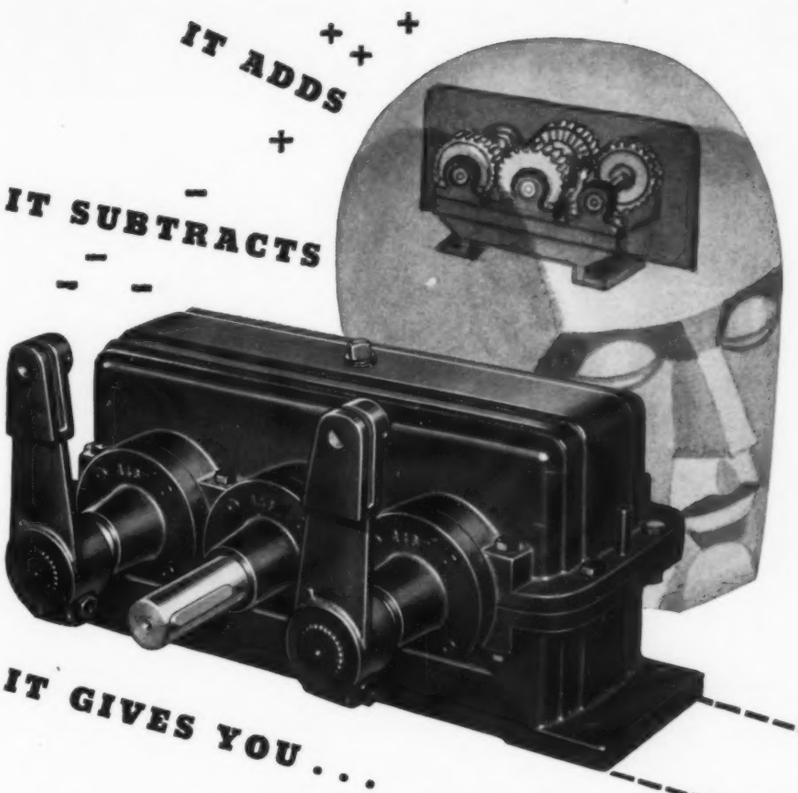

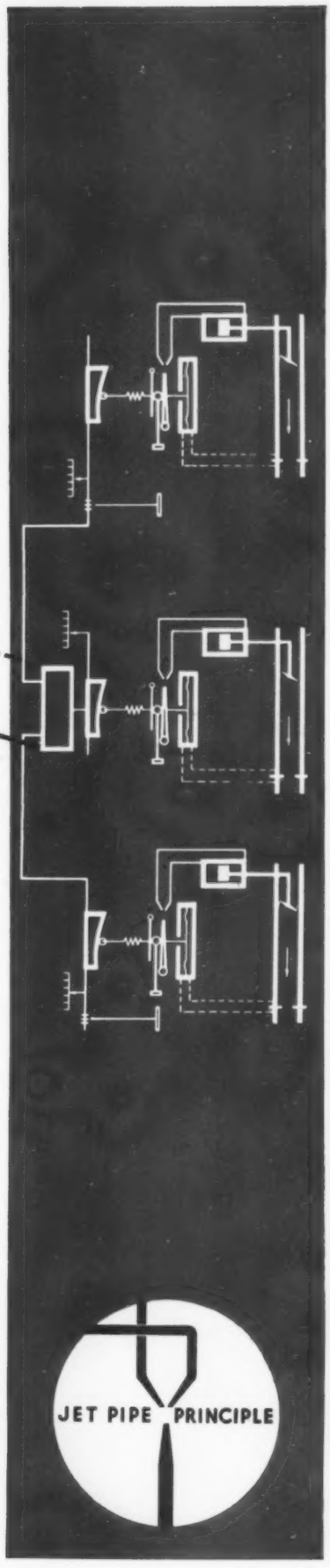

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It's like a mechanical brain . . . it never falters . . . never misses . . . it automatically comes up with the correct air requirement for multi-fuel firing. It compensates for air infiltration . . . uses any flow impulse characteristic and adjusts for various atmospheres . . . It's Askania's Summarizing Gear. Simple . . . Sensitive . . . Dependable . . . Automatic . . . "set it and forget it". It's the best "First Helper" a first helper ever had! It permits him to attend to making steel . . . more steel . . . better steel and in less time. Full details upon request to Askania Regulator Company, 1603 South Michigan Ave., Chicago

ASKANIA
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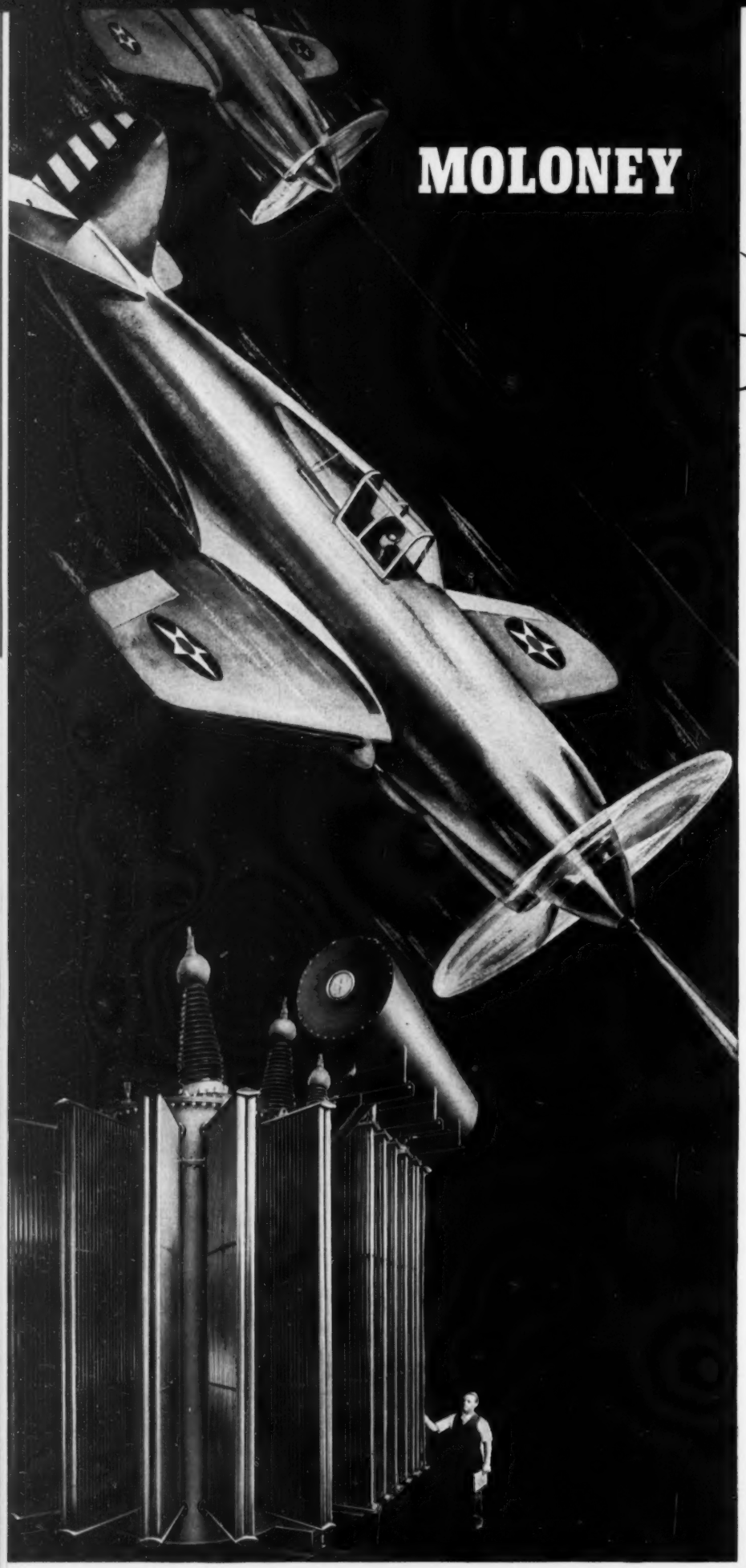
AUTOMATIC CONTROL

JET PIPE PRINCIPLE



Several of these 23,500 Kva 115,000 volt Moloney Transformers supply power for the processing of materials used in the manufacture of bombers and fighting planes.

TRANSFORMERS supply POWER the Key to Victory

POWER Transformers are vital to the delivery of electric power from generating sources to the points of use. *Every day... every minute* these transformers must deliver the power demanded of them... frequently power in excess of their normal capacities. Much depends upon the ability of these transformers to supply unfailing power needs to the tremendous war production program. The manufacture of steel, aluminum, chemicals, machinery, oil, food, in fact, nearly everything necessary for our war effort depends upon a reliable supply of electric power.

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Specify Moloney Power Transformers for your next installation.

MOLONEY ELECTRIC COMPANY
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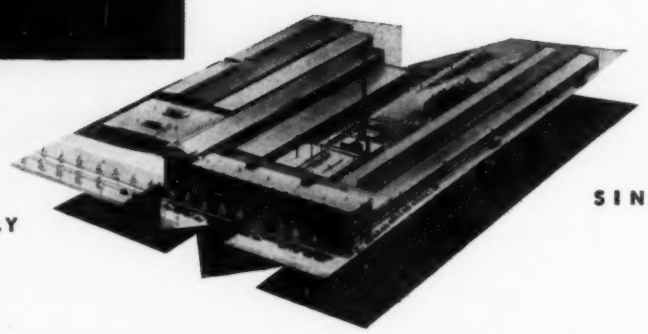

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FOR a good many years we have talked about how Jones speed reducers, gears and other transmission products have been built for long trouble-free service. Some people might have said that we placed too much emphasis on ruggedness, stamina and the ability of our products to "stand up and take it".

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Haste WITHOUT Waste!

SAVE TIME and CONSERVE MATERIAL WITH DELTA-STAR ALL-STEEL CLAMP THREE-CONDUCTOR CABLE SUPPORTS

WAR PRODUCTION demands speed; minutes count. One day's delay of guns, tanks, ships and planes may mean the loss of a decisive battle. Conservation of time and material is imperative; waste is criminal. HASTE WITHOUT WASTE is the order of the day.

Open wiring with DELTA-STAR three-conductor time-and-material-saving cable supports is solution for quick, practical and permanent construction, the best answer for unseen changes — extensions, additional taps and rearrangements can be made quickly and easily.

All conductors are within same clamp — no heating. All-steel clamp eliminates bronze — saves copper, tin and zinc. Close triangular spacing results in balanced circuit with low reactance. Permits multiple circuits of same size conductors — may save delay in securing large cables. High current densities are possible. Occupies minimum space. Furnished with separable bases for pipe, beam, or flat mounting, or with hook for messenger suspension.

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A new interim amendment to the 1940 National Electrical Code permits the use of these supports on circuits up to 600 volts.

ASK FOR BULLETIN 31-F and PUBLICATION 4103-A

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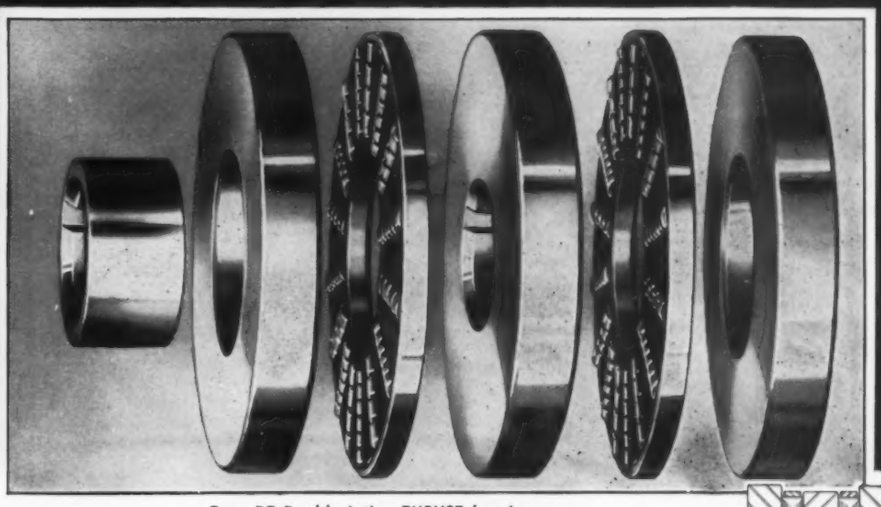
Sure, They'll Carry Heavier Loads at Higher Speeds because

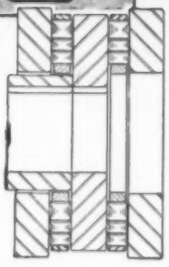
ROLLWAYS carry ONLY ONE* load!

*Only One Load... THRUST!

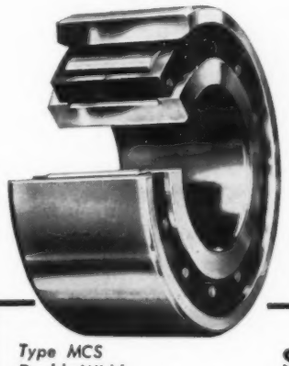
*Only One Load RADIAL!



Type DT Double-Acting THRUST bearing



Their right-angled loading helps to Solve the maintenance problems of the 3-SHIFT, 168-HOUR WEEK!



Type MCS Double Width RADIAL bearing

It's a common error to overlook the destructiveness and magnitude of *thrust* loads—particularly when thrust is not the main component of the load. But whether uniform or variable . . . whether the result of shock, vibration or reversal of torque . . . thrust can seriously affect the life and service of a bearing and of a machine.

That's why Rollway carries every thrust load on a *separate* bearing assembly of solid cylindrical rollers. Load per roller is lower. You get greater roller cross-section per unit of load . . . and greater ability to absorb shock, vibration and wear.

More—you get rid of all oblique and compound stresses with their bothersome resultants. And you get in *thrust* bearings the factors of safety, life expectancy, and low starting torque that you expect in radial bearings.

For longer wear, less service attention and fewer shut-downs, change over now to Rollways, *the roller bearing with right-angled loading.*

STANDARD SIZES FOR MOST APPLICATIONS

Rollway's large number of types and series permit designing to standard metric sizes that are not only correct mechanically and practical from a cost viewpoint, but that are easier to obtain and replace, particularly in times of emergency like these. Send us your designs for free bearing analysis and "engineered to the job" recommendations.

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BUILDING HEAVY-DUTY BEARINGS SINCE 1908 BEARINGS

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A SINGLE RESPONSIBILITY IN ACHIEVING IT

Higher tonnage and uniform quality of product result from efficient control of steel mill equipment. An invaluable aid in achieving this is a system of automatic controls and instruments that allows operators to concentrate on the factors making for optimum production. To secure these results, Republic Flow Meters Co. offers a complete manufacturing and engineering service—a single responsibility—in the field of measurement and control. We will gladly co-operate with you in the solution of any metering or control problem. Your inquiries involve no obligation.

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For furnace pressure, fuel, fuel-air ratio.

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For all boilers, all types of firing.

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For mixing gases in desired ratio.

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For pressure in all types of furnaces.

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For temperatures up to 1000 F.

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Holophane Planned Lighting achieves economy through *control* . . . Now with the national effort straining for conservation, the fundamental economies provided by Holophane equipment are more desirable than ever . . . Artificial lighting is part of the "intermediate" machinery that produces the "immediate" implements of war. The more saved on this "intermediate" equipment the more available for the armament itself.

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A comprehensive guide to scientific war industry illumination. It shows how to plan the most efficient lighting, how to get the full results out of such planning, how to figure costs of installation and maintenance. Available without charge . . .

HOLOPHANE LIGHTING *Converts* WASTE *into* WEAPONS

★ **CONSERVES MATERIALS:** Holophane Lighting units use a minimum of critical materials in their construction.

★ **CONSERVES MAN HOURS:** Holophane Lighting, planned for a specific production situation, creates seeing conditions that mean less man hours per given task, less accidents, less errors and less nerve strain. It also affords economies in maintenance time and expense.

★ **CONSERVES ELECTRIC POWER:** Holophane controlled illumination assures effective light for essential working areas with minimum current consumption.

***CONSULT HOLOPHANE ENGINEERS** . . . They stand ready to help you with expert counsel on any specific lighting problem. Call on them without obligation.*

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Lighting Authorities Since 1898 HOLOPHANE CO., LTD., 385 YONGE ST., TORONTO, CAN.

BAKER TRUCKS

can help you to conserve

Man Power

Here's how —

1. HANDLING MATERIAL FASTER
Saving man-hours means saving man-power. Baker Trucks cut time on handling operations.

2. HANDLING BIGGER LOADS
Baker Trucks, carrying pallet or skid-loads, eliminate piece handling, and release man-power for other work.

3. USING FEWER MEN FOR SAME JOBS
One man with a Baker Truck can do the work of many men with hand trucks.

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Cutting idle time of machines by servicing them with Baker Trucks conserves skilled labor.

5. CUTTING WASTE TIME
Waiting for material wastes man-power. Baker Trucks move material where needed, when needed.

6. DISPOSITION OF SCRAP
Keeping aisles clear and handling scrap efficiently with Baker Trucks saves man hours.

THE BAKER MATERIAL HANDLING ENGINEER CAN HELP YOU

He is a specialist and knows how to get the most out of material handling to conserve man-power. He is at your service.

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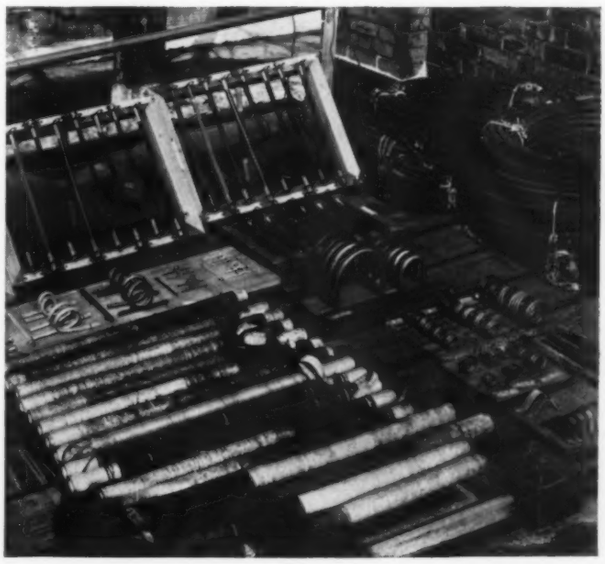
Synthetics are not Substitutes

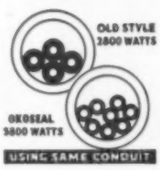
With the sharp curtailment of our rubber supply, the role of synthetics assumes even greater importance than ever.

Intrinsic merit—the ability to obtain qualities which natural products do not possess and thereby broaden the field of usefulness of insulated wires and cables—has been the reason why we have devoted so much time for so many years to intensive study and practical application of such synthetics as Neoprene, Koroseal, and Thiokol. These are the rubber-like compounds which chemists prefer to call "elastomers" and "plastomers." Each of them possesses characteristics which enable us to use them in the making of insulations or protective coverings unlike anything available before.

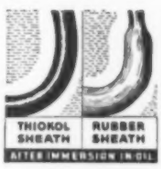


Thus, Okoprene sheaths, which contain 60% neoprene bonded to the insulation itself, do not deteriorate in air or sunlight. They prevent corona-cutting on high voltage cables. They are mechanically strong and highly resistant to abrasion.

Okoseal, Type SN, new small diameter wire, depends on the use of non-inflammable Koroseal. Okoseal permits more wires to be carried in a conduit, thus increasing electrical capacity of any given space. Its resistance to flame makes Okoseal especially suitable for switchboard and panel wiring.



Thiokol is oil-proof and moisture-proof. Thiokol coverings prolong the life of Okonite insulation in many important wiring applications.



These examples are typical of the possibilities opened to you as users of electrical wires and cables through the development of these synthetics. Nor is the end in sight. Already cables with synthetic protection are playing an important part in your field. Although the supply of synthetics is limited right now by heavy war demands, new sources are being built. So that you will be ready to make the most of these improvements, let our engineers show you how synthetics will improve your electrical systems.

THE OKONITE COMPANY
Passaic, New Jersey
Offices in principal cities

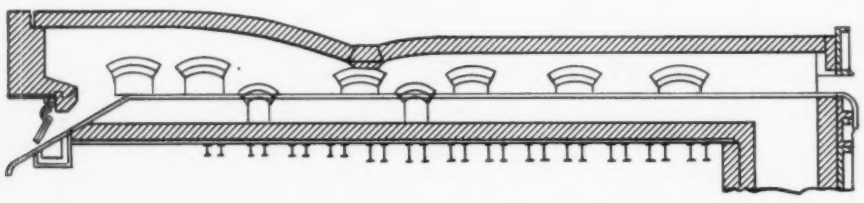
OKONITE
INSULATED WIRE AND CABLES

TO BEST SERVE THE WAR EFFORT . . . MODERNIZE
AND IMPROVE EXISTING FACILITIES

Here's Proof—

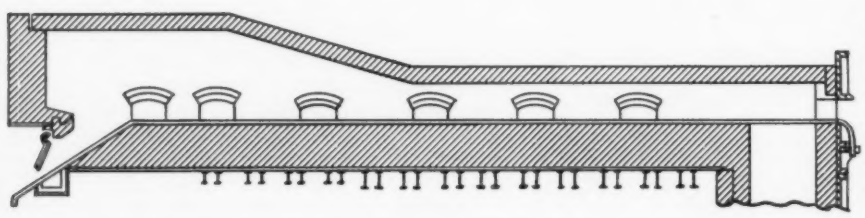
that BLOOM ENGINEERING plus BLOOM EQUIPMENT INCREASES FURNACE OUTPUT REDUCES FUEL CONSUMPTION

1



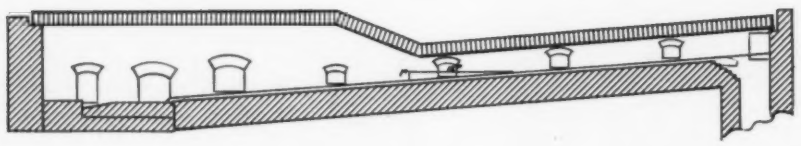
● Production was doubled and fuel consumption reduced 40% when a furnace of this type was re-equipped by Bloom Engineering (change-over took less than seven-days!) Present heating rate—160 lb. steel per sq. ft. per hour.

2



● Several furnaces were converted from water-cooled skids to the solid hearth type shown here, and equipped with Bloom burners. After the change they heated 30% more steel with 50% less fuel. Only two weeks shut down was needed to make the complete change-over.

3



● Bloom Burners in this type of furnace have produced these creditable results:

1. Low Decarburization.
2. Heating rates of 130 lb. per sq. ft. per hour.
3. Fuel consumption as low as 1,200,000 Btu. per ton monthly average with cold air.
4. Fuel consumption less than 1,000,000 Btu. per ton with preheated air.

BLOOM ENGINEERING COMPANY

916 BEHAN STREET . . . . . PITTSBURGH, PA.

"What a whale of a job THAT saved us!"

"When P&H built cranes for us before, we had them do it on our specifications. This time, we simply dropped our problem in their laps. They engineered the entire job down to the last detail . . . showed us new advantages . . . furnished our cranes complete with all electrical apparatus. And that saved us the whole tedious job of drawing up specifications!

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P&H is America's oldest and only crane builder producing complete electrical equipment.

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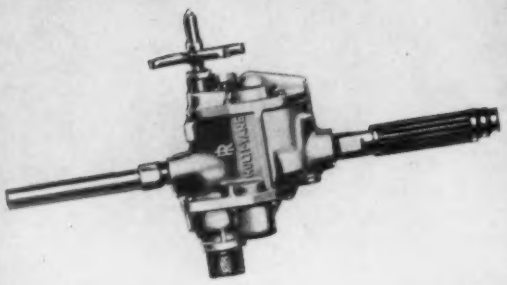
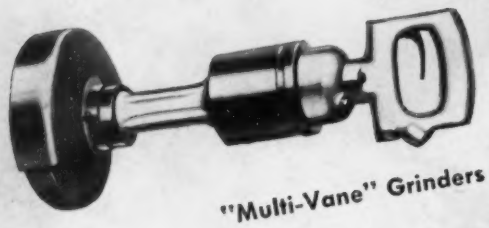
Awarded the Navy "E" for excellence in war production, P&H displays it also as a pledge of future effort.

P&H
OVERHEAD CRANES



"Multi-Vane" Drills

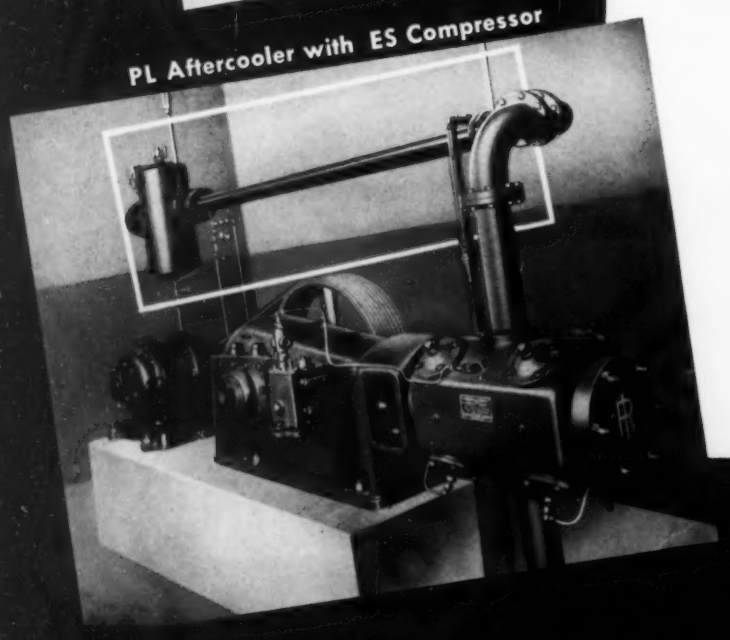
Chipping Hammers



"Multi-Vane" Grinders

Riveting Hammers

Impact Wrenches



PL Aftercooler with ES Compressor

AFTERCOOLERS, SEPARATORS AND LUBRICATORS

enable you to get more out of your AIR TOOLS

We strongly advise the use of aftercoolers, separators, and lubricators in your compressed air system. They enable pneumatic tools to do more work, to stay on the job and to last longer, thus increasing the overall efficiency of your plant.

Aftercoolers and separators take most of the moisture out of the air after it is compressed but before it goes into the transmission system. Water washes away lubricant, causing excessive wear and high maintenance, and sometimes causes both tools and pipe lines to freeze. Aftercoolers eliminate these difficulties.

Since a pneumatic tool has rapidly moving parts, it naturally requires adequate lubrication. Properly placed and serviced air-line lubricators increase air tool efficiency and help to prevent costly breakdowns.

The cost of these modern accessories is relatively small and is almost always justified.

Ingersoll-Rand

11 Broadway, New York City

8-55

AIR TOOLS ARE SMALL, LIGHT AND FLEXIBLE

Pennsylvania

introduces a new

STRAIGHT-LINE TAP CHANGER

for Power Transformers

with

silver-to-silver contacts

RETAINING the fundamental and highly desirable principle of straight-line movement, Pennsylvania introduces valuable improvements in its tap changer for Power Transformers. This new tap changer with its silver-to-silver contacts is capable of carrying heavy overloads without overheating, and is able to withstand "dead" short circuits without detrimental effects. Tests have been made to fully prove these characteristics.

This development is evidence of Pennsylvania's continuous research to provide the utmost in transformer life and reliability — a research increasingly important to Industry's Victory Program.

How it operates

The insulating shaft **(1)** carries on its end a steel gear, which is hidden from view. This gear engages a cadmium plated steel rack **(2)**. The rack carries two self-adjusting and self-aligning steel springs **(3)**. On the end of each spring is mounted a copper jaw with silver inlays **(4)**. The pressure of the spring is transmitted to the movable jaws which make contact by bearing against silver rivets **(5)** imbedded in stationary copper jaws **(6)**. The transformer leads are bolted on to the stationary jaws.

The supporting frame **(7)** is fabricated of insulating material of great mechanical and electrical strength. Electrostatic Shields **(8)** are provided on high voltage tap changers to eliminate corona.

The movable jaw, actuated by the rack and gear, travels in a straight line. No lost motion, no-misalignment!

Life-Tested!

Tap-changer subjected to 100,000 full operations—considerably more than would occur during normal life of a Transformer!

Pennsylvania TRANSFORMER COMPANY

808 RIDGE AVENUE, • N. S., PITTSBURGH, PA.

Today American Industry must have efficient and dependable operating equipment. Over a quarter of a century's experience in the manufacture of Oil Immersed Motor Control equipment is your assurance of dependability in Rowan products.
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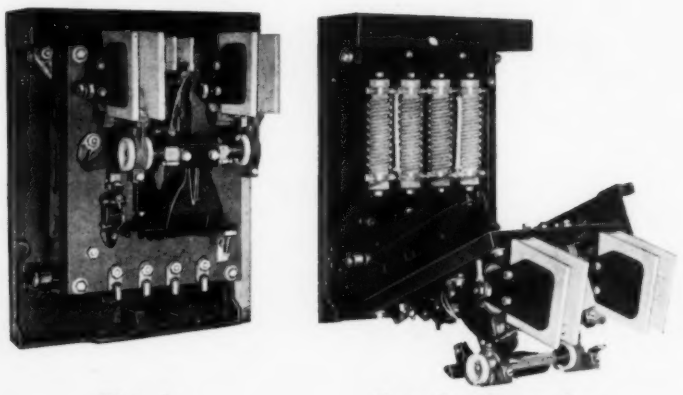
OHIO

QUICK DROP MAGNET CONTROLLER

With arc suppressor and quick drop, automatic for any class of material.



Closed — Open for Inspection

Two main switches open circuit in series. Reverse and quick drop are automatic. Master contacts carry control circuits only.

The arc suppressor reduces the arc so it is not harmful or disagreeable. Contact tips are thus saved. Arc shields do not burn.

This controller makes possible 6 or more lifts per minute which is as fast operation as any we have ever observed in practice.

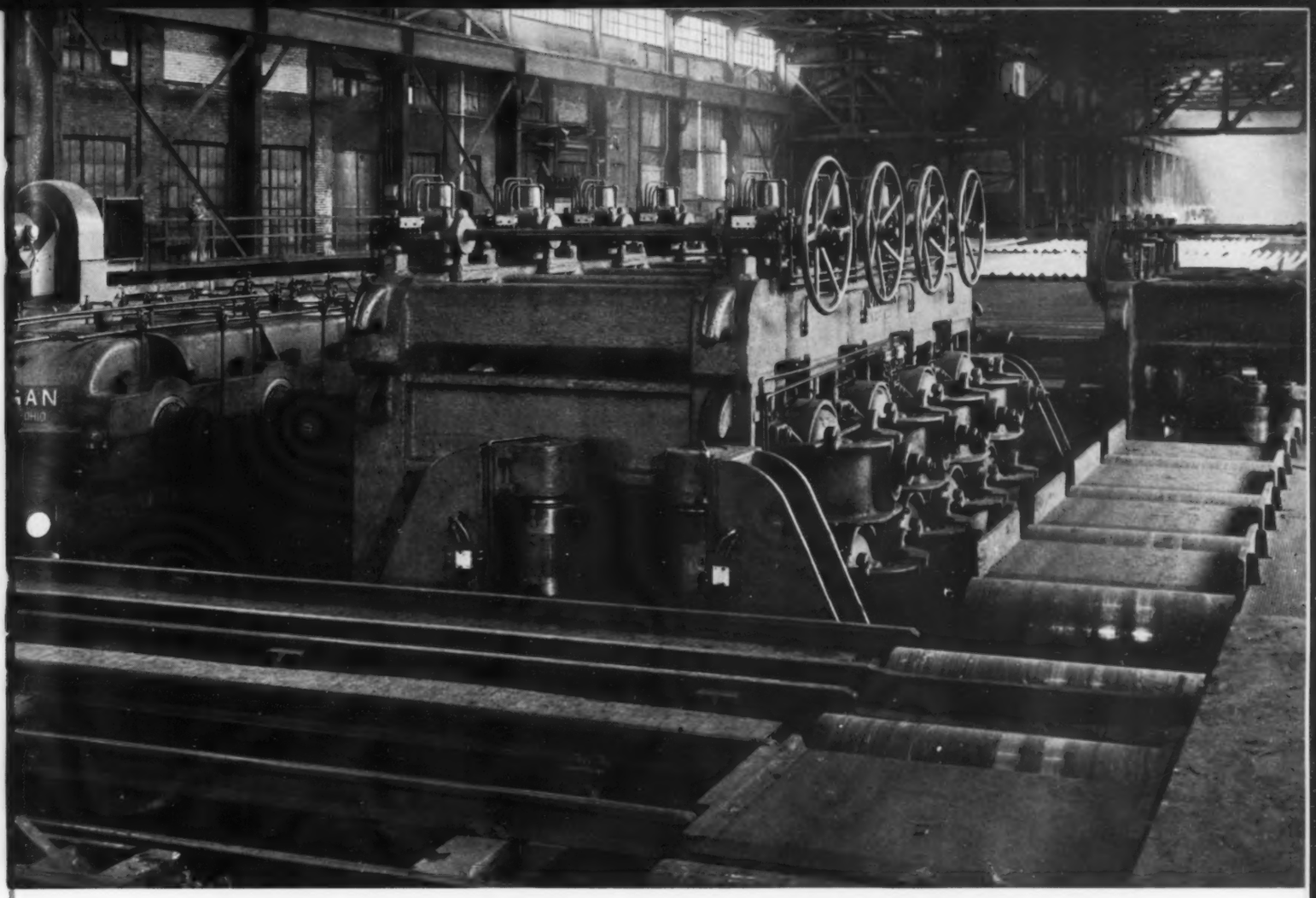
●

OHIO reliable MAGNETS

The OHIO Electric Mfg. Company

5907 Maurice Avenue

Cleveland · · Ohio



24″ I BEAM STRAIGHTENER

● Illustrated is a Morgan Roller Straightener for structural shapes up to 24″ I beams.

It is equipped with four top and four bottom rolls, all of which are adjustable. These eight rolls are arranged to be connected by spindles to a separate enclosed gear box drive. All gear shafts are mounted in roller bearings. Vertical rolls are provided on both entry and delivery sides.

A section of roller table is mounted on one side of straightener to be shifted into the roller table line when straightener is not in use.

BUILT BY MORGAN *Engineering*

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ALLIANCE, OHIO
Pittsburgh, 1420 Oliver Building

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Throw Your Space Into the Right

PRODUCTION *plus* PROTECTION

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Colt Motor Controls are built to "take it" under today's grind of 24-hour-a-day production schedules. All shifts can depend upon the design and rugged construction of Colt Controls for full-time, full-speed operation.

THERE IS A COMPLETE LINE OF COLT MOTOR CONTROLS

Manual Motor Starters
Manual Reversing Starters
Manual 2-Speed Starters
Magnetic Contactors - Magnetic Motor Starters
Magnetic Reversing Contactors and Starters
Multi - Speed Starters - Relays
Combination Starters - Push Button Stations

COLT'S PATENT FIRE ARMS MFG. CO. - Electrical Division - HARTFORD, CONN.

Don't Waste Time

With Dripping, Leaking Oil

Production is vital today. You can't take chances with oils that do not lubricate dependably.

Ordinary oils won't stay in bearings so do not protect hard-working machines from break-downs. Then too, they are costly because of waste.

NON-FLUID OIL is drip-less and waste-less, so protects bearings by lubricating continuously until entirely consumed. Helps keep production up and machine repairs down. Saves money too, by outlasting oil three to five times.

Used successfully in leading iron and steel mills. Send for instructive bulletins.

•

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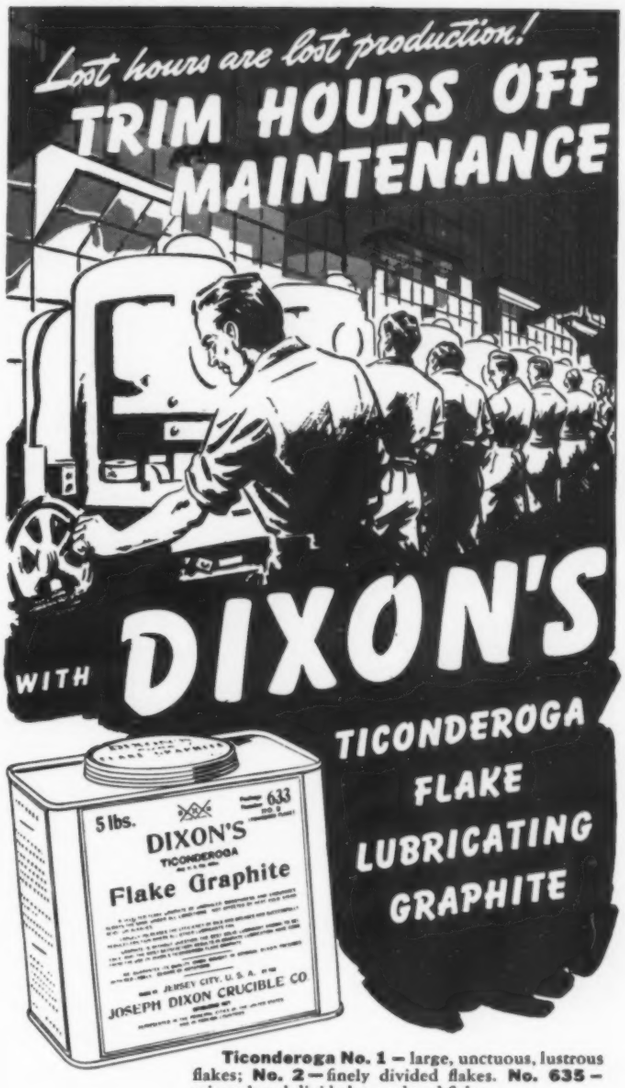
MODERN STEEL MILL LUBRICANT

Better Lubrication at Less Cost per Month



Ticonderoga No. 1 — large, unctuous, lustrous flakes; **No. 2** — finely divided flakes. **No. 635** — minutely subdivided, powdered flakes.

Normal lubrication is inadequate under abnormal production loads. DIXON'S TICONDEROGA Flake Lubricating Graphite, dry or as a co-lubricant, stands up where ordinary lubricants fall down—reducing maintenance time, saving power, preserving machinery and in making tight but easily separable pipe joints. Only graphite can perform these services, and DIXON'S TICONDEROGA excels in lubricity, uniformity, purity.

DIXON'S ROLL NECK GRAPHITE LUBRICANTS FOR ALL PLAIN OPEN BEARINGS SAVE ROLLS, BRASSES, LUBRICANT AND LUBRICATION COST.

Dixon's Graphite products are sold by leading industrial distributors.

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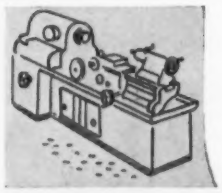


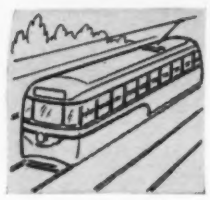
Prolong life and increase efficiency of your electrical equipment by proper maintenance

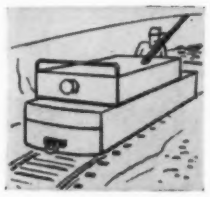
● Today's conditions demand that we keep our operating equipment at peak performance. To assist in this task National Carbon Company, Inc. issues a series of bulletins under the title "Modern Pyramids." These deal with practical information on Commutation, Brush Operation and Machine Maintenance to help conserve present equipment and keep it operating at full efficiency. If you are not already receiving these bulletins, write us direct or contact your National Carbon representative. He will be glad to assist you in interpreting the bulletins and in selecting the proper grade of "National" brush for most efficient operation of your motors and generators. The services of our experienced engineering staff are also available to users of "National" brushes for the solution of difficult brush problems.

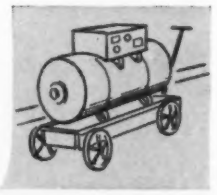
★ CONSERVE COPPER ★

Copper is of prime importance in the national war effort. You can help conserve this essential metal by detaching and saving shunts and connections from worn-out brushes. The copper you save in this way can be turned over to local salvage agencies to be returned to the nation's supply and thus find its way back into some war task.

Join the drive to conserve essential metals today. Start a copper collection box in your plant.







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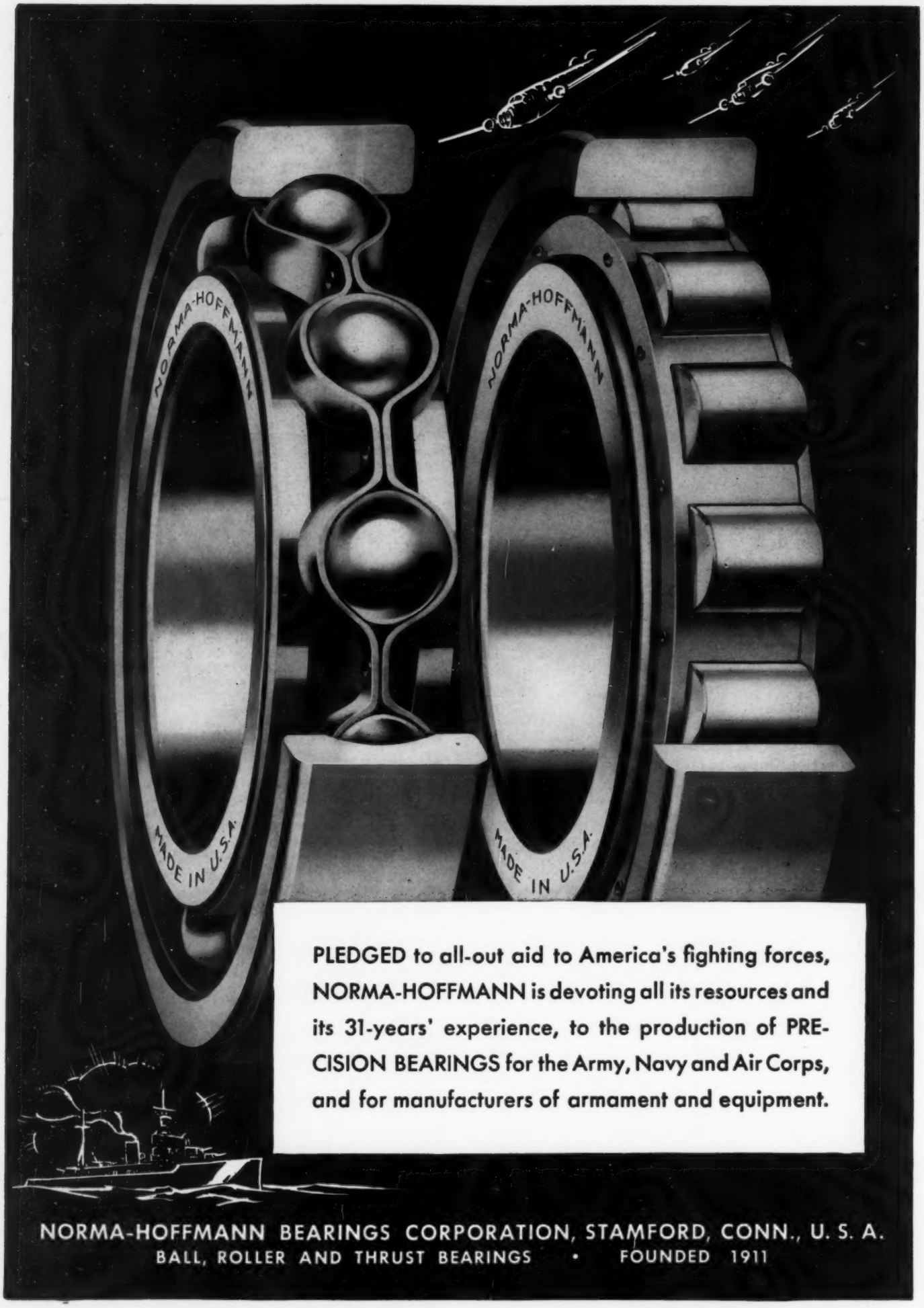

PLEDGED to all-out aid to America's fighting forces, NORMA-HOFFMANN is devoting all its resources and its 31-years' experience, to the production of PRECISION BEARINGS for the Army, Navy and Air Corps, and for manufacturers of armament and equipment.

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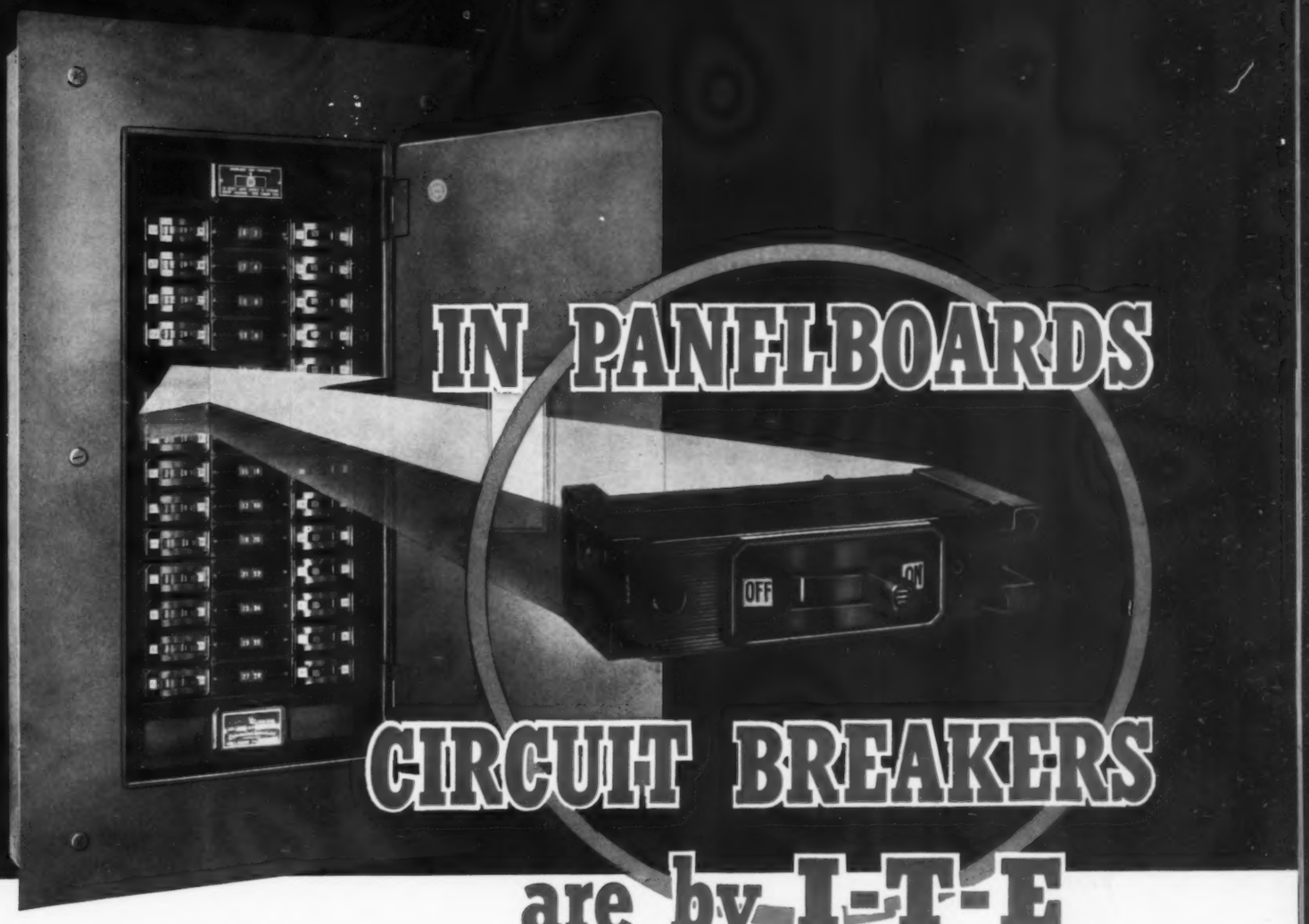

IN PANELBOARDS

CIRCUIT BREAKERS

are by I-T-E

These are readily identified as the work of I-T-E

Steel-enclosed switchboards and individually mounted circuit breakers have carried the I-T-E symbol into the plants of industry. These units represent the work for which I-T-E is known. But, as the text at the right indicates, the field of I-T-E usefulness is even greater.

Another example of a broad, essential service by I-T-E which only a few people would ordinarily know about

Throughout the country are hundreds of electrical contractors who install panelboards in which "switches" for control of lighting circuits in buildings and factories are conveniently centered.

In modern practice, the "switches" are circuit breakers especially designed for panelboard use to provide positive, fuseless protection for each circuit while permitting "off-on" manual control.

A very great many contractors use panelboards and convertible power panels made with I-T-E circuit breakers and I-T-E accessories. Many thousands of I-T-E units are purchased for panelboards and power panels each year. Yet, because the circuit breakers are grouped behind solid, sheet-steel coverings and because the people who have reason to open panelboard doors are few, the identity of the circuit breakers is not generally known.

Of men in industry who read of this widespread use of I-T-E equipment, some large percentage will be working in plants and office buildings in which are panelboards containing I-T-E units. Such readers—and others—may gain a new picture of I-T-E contributions. The part of I-T-E in the field of electrical protection is broad.

Representatives in Principal Cities

I-T-E

AIR SWITCHGEAR

IMMERSED IN AIR — ENCASED IN STEEL

The Army-Navy "E" for Production Excellence

I-T-E CIRCUIT BREAKER CO., PHILADELPHIA, PA.

NEED MOTORS FOR WAR WORK?

4 things to do to get them quicker

YOUR AID ON THESE 4 POINTS WILL HELP US PRODUCE AND DELIVER MORE MOTORS

Tri-Clad motors are available in a full range of sizes from 1 to 100 hp. Your General Electric representative can supply complete information and help you get the Tri-Clad motor to do your job. *General Electric, Schenectady, N. Y.*

Your choice of G-E Tri-Clad motors will give you *extra protection* against (1) physical damage, (2) electrical breakdown, (3) operating wear.

General Electric and its employees are proud of the Navy award of Excellence made to its Erie Works for the manufacture of naval ordnance

SPECIFY *TRI CLAD* MOTORS

GENERAL ELECTRIC

Use standard, open, sleeve-bearing motors whenever possible

The standard Tri-Clad motor, though classed as an "open" motor, is so well protected that it gives good service on many jobs where special motors often were recommended.

Sleeve-bearing motors often can be supplied more readily than ball-bearing types because of the present demand for ball bearings on other war equipment. Use ball-bearing motors only where load or mounting conditions require them.

Special end shields and other modifications may result in delay for you and others.

Consider the use of standard or multispeed a-c motors in place of d-c motors wherever this alternative is possible

order motors early . . . giving complete specifications

Place motor orders when you order the machines they are to drive.

If you are planning motor drives for conveyors or other equipment for new plants, place the orders as soon as design work indicates the motor requirements.

Avoid delay and mix-ups by giving complete specifications, preferably on an order form which your G-E motor representative can supply.

give complete priority information, properly endorsed

The filling of many motor orders is delayed because of incomplete priority information. If in doubt about details, call the nearest G-E office.

When placing orders for motors, be sure that complete priority data accompanies *each order* in the form of certificates, endorsements properly signed, etc. The priority is not effective in scheduling shipment until it is received by your supplier.

Your needs and the war effort are best served by using the proper priority rating assigned by the War Production Board for the job involved, and requesting delivery no earlier than actually required.

Under the Production Requirements Plan, builders of motor-equipped machines for subsequent sale may order their requirements in advance.

check with G.E. for delivery from local warehouse stocks

To meet urgent war needs, a supply of standard Tri-Clad motors is maintained at G-E factories and local G-E warehouses. Perhaps the motor you want, or can use with a few simple changes, is available for immediate shipment.

Your local G-E motor representative can furnish information on motors which may be in stock in the following cities:

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Boston, Mass.
Buffalo, N. Y.
Charleston, W. Va.
Chicago, Ill.
Cincinnati, Ohio
Cleveland, Ohio
Dallas, Texas
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Houston, Texas
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